2. CURRENT CONDITIONS

The watersheds of the San Gabriel and Los Angeles Rivers cover 1,513 square miles, from the San Gabriel Mountains in the north to the Pacific Ocean at Long Beach (**Figure 2-1**). The two rivers arise from springs and creeks in the mountains surrounding the Los Angeles basin, flow across the San Gabriel and San Fernando Valleys, then flow nearly parallel across the coastal plain to the Pacific Ocean.

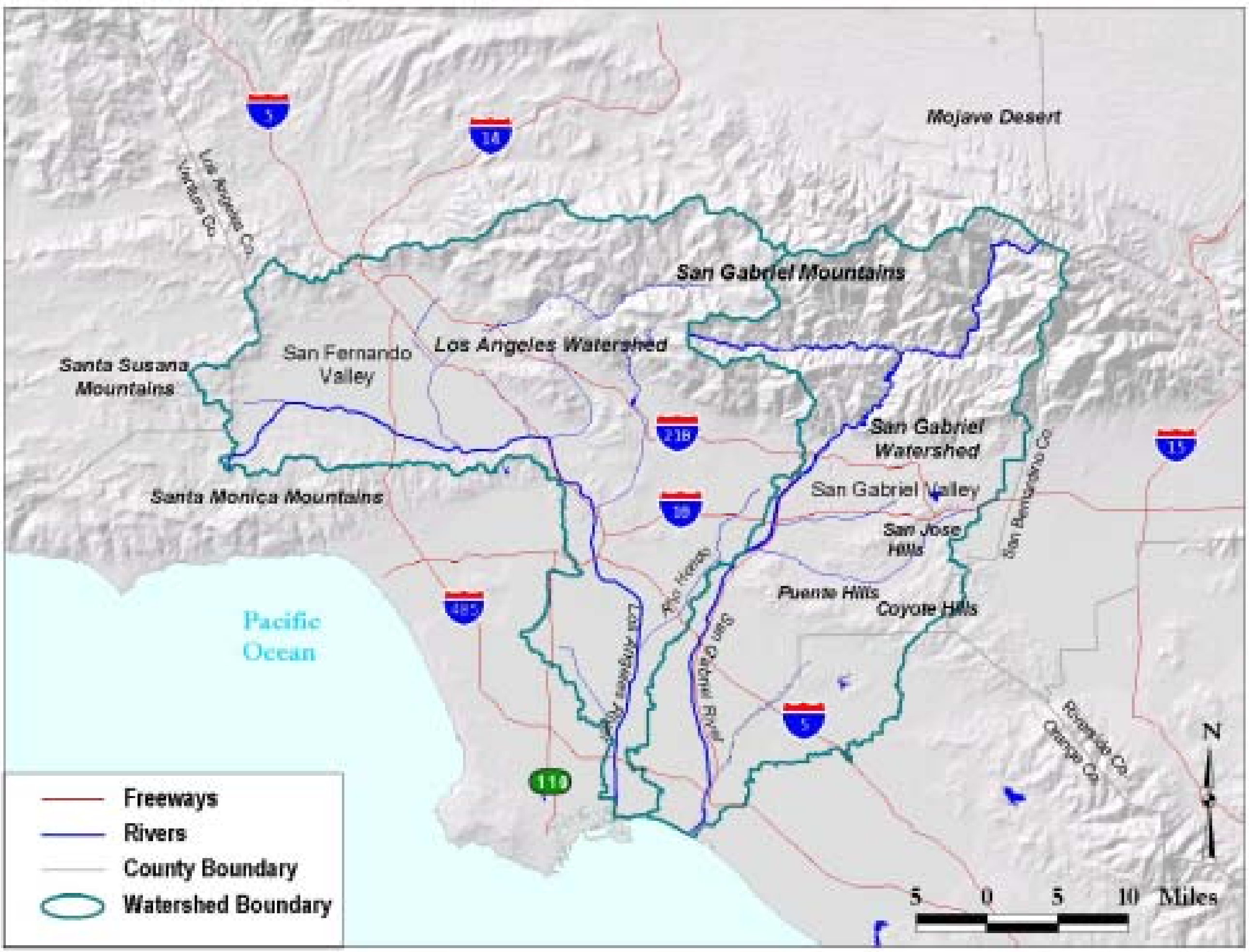

Figure 2-1. San Gabriel and Los Angeles Rivers Watersheds

The rivers have an engineered connection via the Rio Hondo, a major tributary of the Los Angeles River that flows, along with the San Gabriel, into the Whittier Narrows Dam and Reservoir.

The region within the watersheds is geographically diverse, particularly in terms of its topography, climate, land use, and habitat types. Urbanization during the latter half of the twentieth century has had a considerable impact on natural resources, altering the hydrology in the watersheds and significantly reducing the extent of natural habitat and biotic communities.

The purpose of this section is to provide a primer for planning in the watersheds and an atlas of the geography of the region: its physiography, climate, hydrology, water quality and quantity, recreation and open space, natural habitat and demographic characteristics.

A. PHYSICAL SETTING

1. Geology and Geomorphology

The mountains surrounding the San Gabriel-Los Angeles basins are part of the Transverse Ranges, which extend 350 miles east to west from the Eagle Mountains in San Bernardino County to the Pacific Ocean. To the north, the San Gabriel Mountains separate the basin from the Mojave Desert. To the west, the Santa Monica Mountains separate the watersheds from the Ventura basin. Topography in the watersheds ranges from sea level to over 10,000 feet in the San Gabriel Mountains. Most of the coastal plain is less than 1,000 feet in elevation. The foothills reach 3–4,000 feet before rising rapidly into the San Gabriels, to a height of 10,064 at Mt. San Antonio (Mt. Baldy). The grade of the mountain slopes averages 65–70 percent, some of the steepest slopes in the world.

Geology varies from Precambrian metamorphic rocks (1.7 billion years old) to alluvial deposits washed down from mountain canyons. The San Gabriel Mountains are young mountains, geologically speaking, and continue to rise at a rate of nearly three-quarters of an inch per year. Because of this instability, they are also eroding at a rapid rate. Alluvial deposits of sand, gravel, clay and silt in the coastal plain run thousands of feet thick in some areas, due in part to the erosive nature of the San Gabriel and Santa Monica Mountains.

The region is extensively faulted, with the San Andreas Fault bordering the north side of the San Gabriels and the Sierra Madre–Cucamonga fault zone on the south side. Throughout the basin are hundreds of lesser fault systems, such as the Newport-Inglewood fault that runs from Newport Beach to Beverly Hills via Long Beach and Signal Hill. The most notorious are those that have been the cause of major earthquakes during the past few decades, known not by name but by the region in which they struck: Sylmar in 1971, Whittier Narrows in 1987, and Northridge in 1994. The San Andreas Fault, which traverses California for 625 miles from the San Bernardino Mountains to Northern California, has not generated an earthquake in the Los Angeles area since the Tejon Ranch earthquake in 1857.

Fire is also an integral and necessary part of the natural environment and plays a role in shaping the landscape. Chaparral, the dominant natural vegetation type on slopes throughout the region, is extremely fire-prone. Brush fires leave the soil exposed and unprotected. These bare areas, in combination with steep slopes and erosive mountains, enable runoff from winter rains to suspend large quantities of coarse mineral debris, rocks, and vegetation and wash it downslope and into streams. These debris flows can erode the landscape, clog stream channels, damage structures, and injure inhabitants in the canyons and lower foothill areas.

2. Climate

The watersheds are within the Mediterranean climate zone, which extends from Central California to San Diego. Wet winters and long dry summers characterize this climate. The extent of this climate type is limited worldwide. Other than the central and south coast of California, it only occurs in coastal zones along the Mediterranean Sea, Western and Southern Australia, the Chilean coast and the Cape Town region of South Africa.

The geography of the Los Angeles region results in a great deal of spatial variation in the local climate. The abrupt rise of the mountains from the coast creates a barrier that traps moist ocean air against the southerly slopes and partially blocks the desert summer heat and winter cold from the interior northeast. The common perception of the region as desert is misleading. The coastal plain may be more appropriately termed "semi-arid," and the mountains receive considerable snow and rainfall most years. Average daytime summer and winter temperatures range from 76/65F° on the coast, to 90/66F° in the interior valleys and 81/56F° in the mountains.

Summers are dry, with most precipitation falling in a few major storm events between November and March (**Figure 2-2**). Long-term annual rainfall averages vary from 12.2 inches along the coast, 15.5 inches in downtown Los Angeles to 27.5 inches in the mountains (**Figures 2-3 and 2-4**). For any given storm event, rainfall totals vary significantly by region. Moisture-laden air from the ocean moves up the mountain slopes, expanding and cooling as it rises. Cooler air can hold less moisture, thus produces more precipitation. On the lee side of the

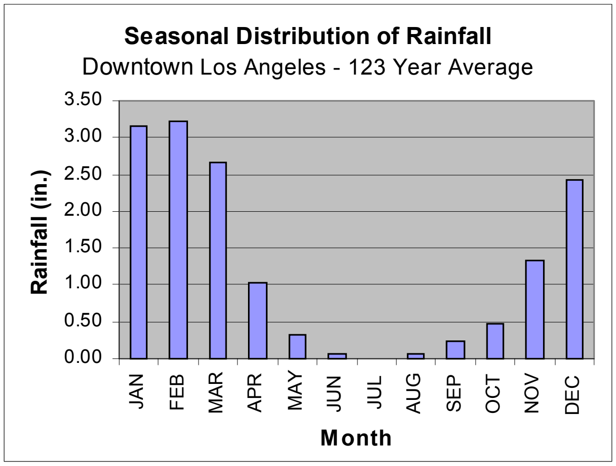

Figure 2-2. Seasonal Variation in Rainfall Amounts
Source: Western Regional Climate Center

mountains, descending air mass warms as it reaches the desert, releasing any remaining moisture through evaporation. A 24-hour storm that produces one inch of rain along the coast can generate 10–20 inches of rainfall in the mountains and just a trace in the desert. The maximum-recorded 24-hour rainfall in the watersheds was 34 inches in the mountains and 9 inches on the coastal plain.

Most winter storms come from the northwest, moving across Southern California into Arizona. The closer the center of the storm is, the more rain it will bring, with snow levels frequently reaching down to 5,000 feet. These are the typical storms that occur in the basin, bringing ¾ inch or less of rainfall. Storms from the south or southwest are less common, but may bring 3–6 inches of rain in the basin and 3–6 feet of snow above 6,000 feet. These storms tend to stall off the coast, which makes their arrival difficult to predict. Storms from the west are least common but last the longest, characterized by a series of rain events each bringing 1–2 inches of rain over a period of 36–48 hours. Summer rains are rare, but when they occur they are a result of tropical thunderstorms originating in the Gulf of Mexico or late summer hurricanes off the West Coast of Mexico.

Air pressure also plays a role in the local climate. In the late spring and early summer, a low-pressure area inland draws a moist marine layer in from the ocean, resulting in coastal fog and low clouds, which moderate temperatures in the basin. The difference in air pressure between the ocean and the desert

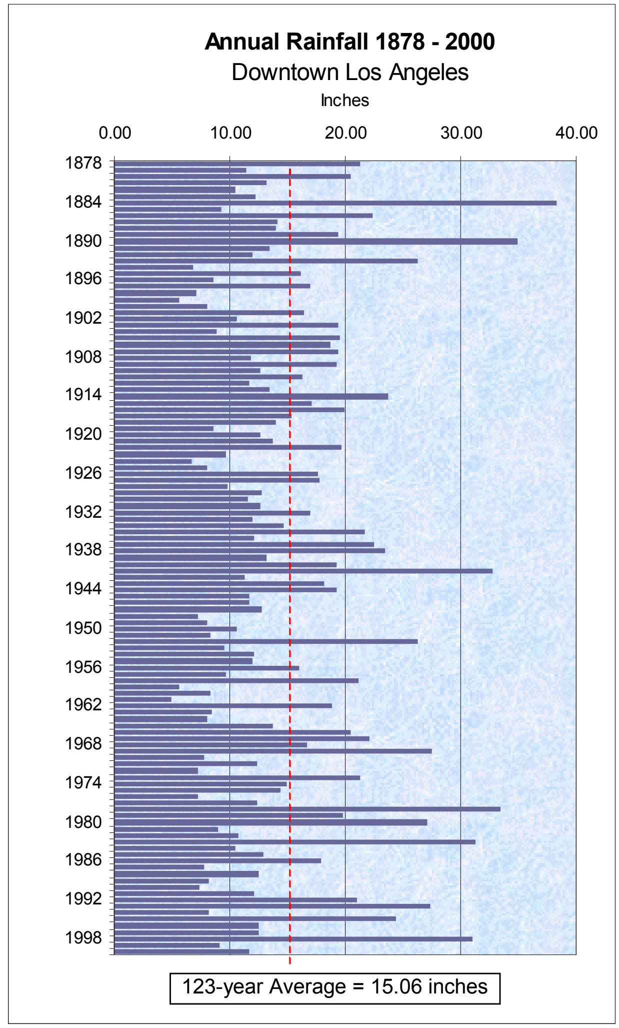

Figure 2-3. Long-term Variation in Rainfall Amounts
Source: Western Regional Climate Center

determines the extent of the marine layer. High-pressure systems off the coast also result in offshore breezes, as air moves from the ocean towards lower pressure areas in the basin.

B. WATERSHED HYDROLOGY

Most of the watersheds (93 percent) lie within Los Angeles County. The San Gabriel River flows from the San Gabriel Mountains, in the Angeles National Forest. Its tributaries drain portions of the Chino, San Jose, and Puente Hills. The Los Angeles River originates at the junction of Calabasas and Bell Creeks in the western San Fernando Valley, and is fed by other tributaries that drain the Santa Monica and Santa Susana Mountains, the Simi Hills, and the western San Gabriel Mountains. Coyote Creek, a tributary of the San Gabriel River, drains portions of both Los Angeles and Orange Counties (**Figure 2-5**).

1. Surface Water

There are twenty major sub-watersheds, shown in **Figure 2-5**. The major tributaries of the San Gabriel River include the West Fork of the San Gabriel, Walnut Creek, San Jose Creek, and Coyote Creek. For the Los Angeles River, major tributaries include the Tujunga, Pacoima and Verdugo Washes, Arroyo Seco, Rio Hondo and Compton Creek. There are nearly 2,000 stream miles in the watersheds, and one-quarter of those streams flow year-round.

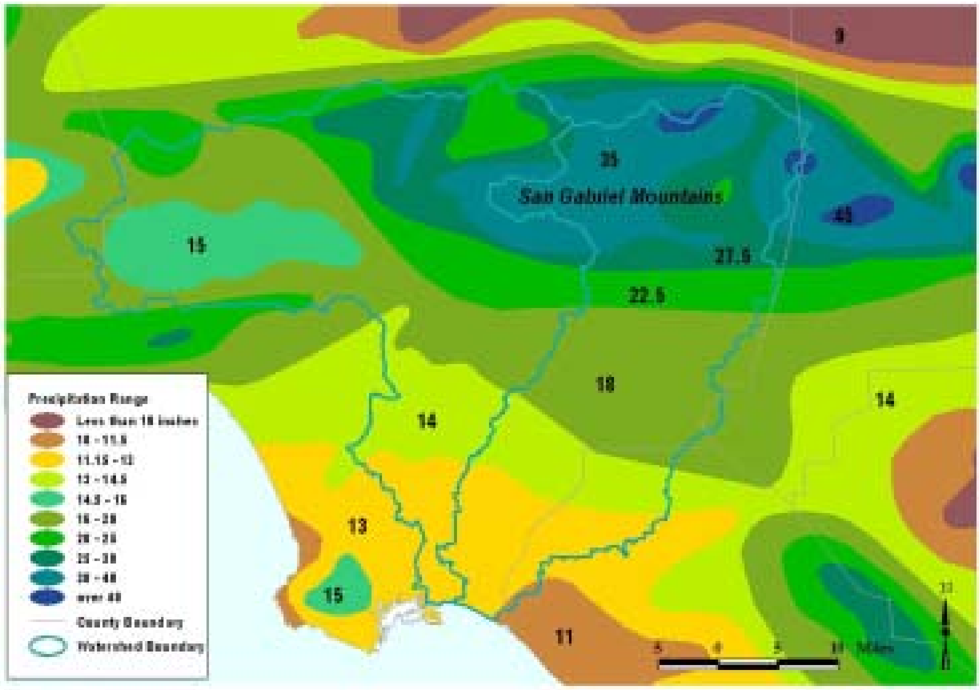

Figure 2-4. Spatial Variation of Average Precipitation in the Watersheds
Source: California Department of Fish & Game

■ Lakes and Reservoirs

The coastal plain at one time supported a number of shallow lakes and ponds fed by springs and by the rivers. Many of these lakes have disappeared as the rivers have been modified. A network of reservoirs has been constructed along the rivers and major tributaries, which are managed for water supply, flood protection, groundwater recharge and in some cases recreation. In total there are 92 lakes and reservoirs within the watersheds. Twenty of these are reservoirs operated by Los Angeles County or the Army Corps of Engineers (**Figure 2-13**).

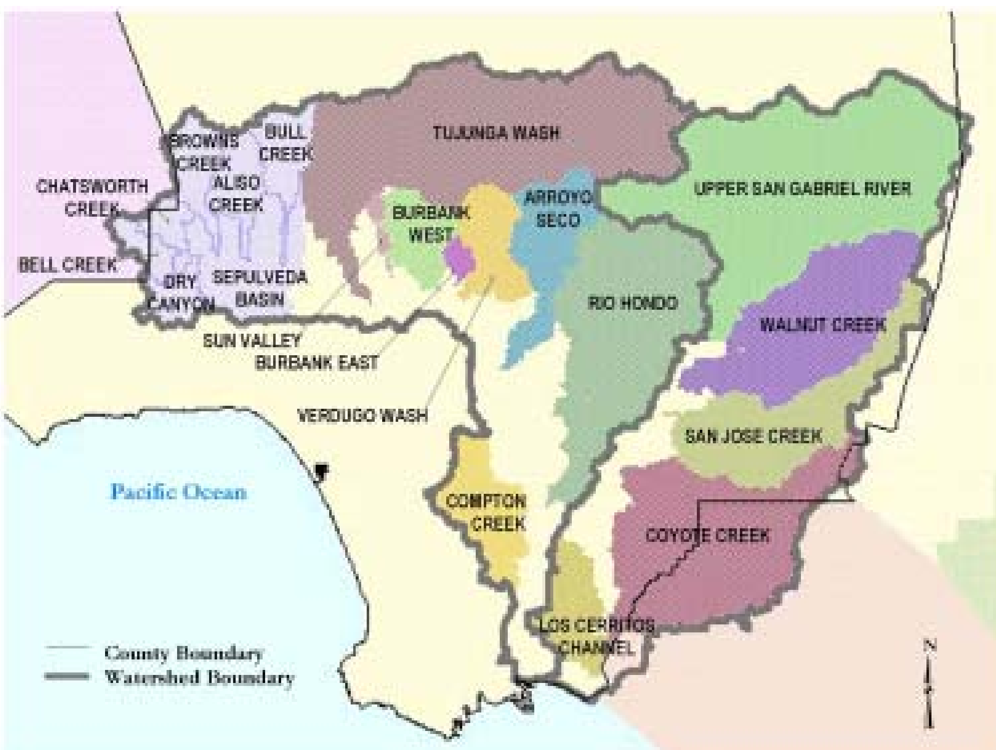

Figure 2-5. Major Sub-watersheds of the San Gabriel and Los Angeles Rivers
Adapted from L. A. County Department of Public Works

■ Wetlands

Historically, extensive wetlands existed throughout the San Gabriel and Los Angeles river basins, both fresh and saltwater. Marshes and ephemeral ponds occurred near the cities of Torrance and Long Beach, and along Compton Creek and other tributaries. Tidal marsh occurred along the coast near San Pedro and at the mouths of both rivers. The historical distribution of wetlands in Los Angeles and northern Orange County is shown in **Figure 2.6a**.

Nearly all of these historic wetland areas have been lost to urbanization, marinas, flood protection measures, or stream channelization. According to the Coastal Conservancy, within the Los Angeles River watershed overall, 100 percent of the original lower riverine and tidal marsh and 98 percent of all inland freshwater marsh and ephemeral ponds have been drained or filled. Some of these losses have been offset by constructed or restored wetlands, primarily behind flood management structures such as the Sepulveda Basin, Santa Fe Dam, and Whittier Narrows Basin. The current distribution of wetlands in Southern California is shown on **Figure 2-6b**. The most substantial remaining historic wetland areas include:

- El Dorado wetlands near the confluence of Coyote Creek and the San Gabriel River
- Los Cerritos wetlands near the mouth of the San Gabriel River (Bixby Ranch and Hellman Ranch), which are degraded from oil drilling operations
- Lower Compton Creek where the channel bottom is unlined
- Saltwater marsh along the banks at the lowest reach of the Los Angeles River below Willow Street and the Golden Shores wetland near the river's mouth in Long Beach
- Pockets of freshwater marsh in Torrance
- Seal Beach National Wildlife Refuge wetlands at the Naval Weapons Station

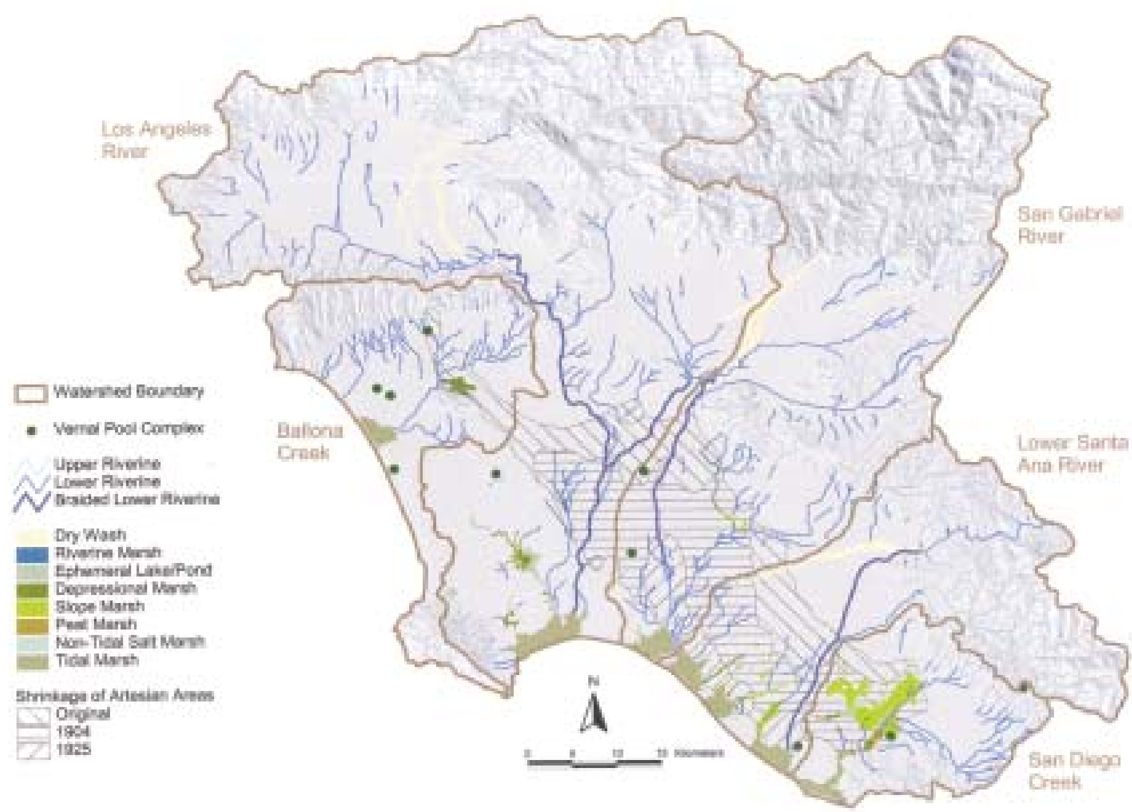

Figure 2-6a. Historical (Circa 1870) Distribution of Wetlands
Adapted from Rairdan, 1998

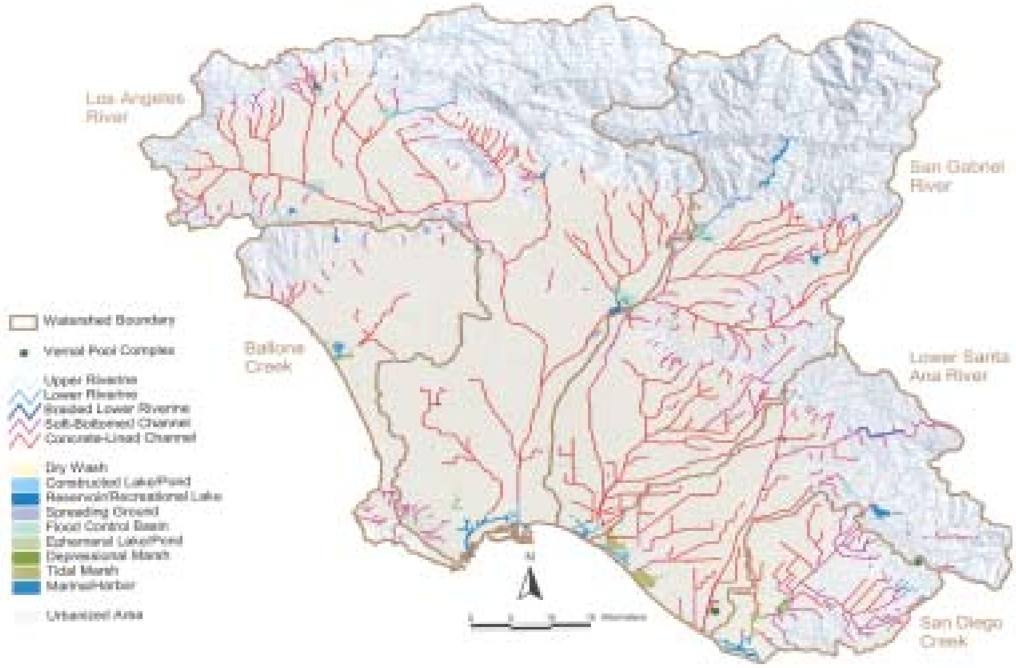

Figure 2-6b. Current Distribution of Wetlands
Adapted from Rairdan, 1998

2. Channel and Flow Conditions on the Major River Reaches

■ Historical Conditions

The flow of the San Gabriel and Los Angeles Rivers was historically dependent upon climate. The rivers derived their flow from snowmelt from the mountains, surface runoff from storms and contributions from springs and groundwater. The rivers were shallow with braided channels and wide floodplains. They frequently carved new channels in their floodplains during heavy winter storms and have altered their courses several times.

During the late eighteenth and nineteenth centuries, ranching and agriculture dominated the San Gabriel and Los Angeles River basins. Flooding in the valleys and periodic droughts made permanent settlements difficult. The Los Angeles River was the sole source of water for the developing city of Los Angeles until the Los Angeles-Owens River Aqueduct was completed in 1913. Diversions from both rivers for agricultural irrigation and drinking water reduced their natural flow, although their propensity for winter flooding was unabated.

■ Existing Conditions

Until the 1930s, both the San Gabriel and Los Angeles Rivers and their tributaries were primarily natural bottom streams. Now, over seventy-five percent of the streams are concrete-lined channels, modified for flood protection purposes. Tributaries originating in the San Gabriel and Santa Monica Mountains or the local hills, such as the Arroyo Seco and Tujunga Wash, remain natural channels in their upper reaches but have been converted to concrete channels in their lower reaches. Upper Compton Creek is channelized, but the lower Creek still has a soft-bottom stream channel.

Upper Arroyo Seco

The upper San Gabriel River and its tributaries remain in a relatively pristine state. However, the river has been extensively modified in the middle and lower reaches for flood management. The lowest reach of the river is concrete-lined channel for approximately eight miles, with riprap banks and soft-bottom channel upstream of the concrete-lined channel and near the river's mouth where it is under tidal influence.

Channelization of the Los Angeles River was completed in 1954 for most of its 51-mile length. There are a few stretches where the high water table or other conditions required that the river bottom be left unpaved. These include the six-mile reach through Glendale Narrows near Griffith Park and one and a half miles through the Sepulveda Basin. The lowest 2.6 miles of the river, which are under tidal influence, are natural streambed with riprap-lined banks.

Flood protection efforts began along the San Gabriel River in 1932 with construction beginning on three dams in the upper reaches of the river. Cogswell Dam, on the West Fork, was completed in 1934. Morris Dam was completed in 1935 and San Gabriel Dam was completed in 1939. Two dams on the coastal plain, the Santa Fe Dam and the Whittier Narrows Dam, were completed in 1949 and 1957, respectively.

Urbanization has altered the natural flow and the runoff regime in the basin, increasing both the velocity and volume of water flowing through the rivers (**Figure 2-7**). Prior to 1960, the ratio of rainfall to runoff was approximately 4:1, meaning that 80 percent of the precipitation in the basin was either evaporated or infiltrated and 20 percent was converted to surface runoff. By 1990 that ratio had increased to 2:1. Now, approximately 50 percent of all precipitation is converted to surface runoff. (This is a very rough estimate, and does not account for flow increases as a result of wastewater discharges, or diversions from the rivers for groundwater recharge.)

Sources of Base Flow

In a few reaches of the rivers, the groundwater table is high and contributes to river flows seasonally. For the most part, base flow comes from snowmelt and headwaters streams in the San Gabriel Mountains, urban and agricultural runoff, and treated wastewater discharges. During the dry season, flow is dominated by treated wastewater discharges, particularly in the lower reaches of the rivers.

C. HABITAT

Because of its varied climate and topography, Southern California is biologically diverse. Within

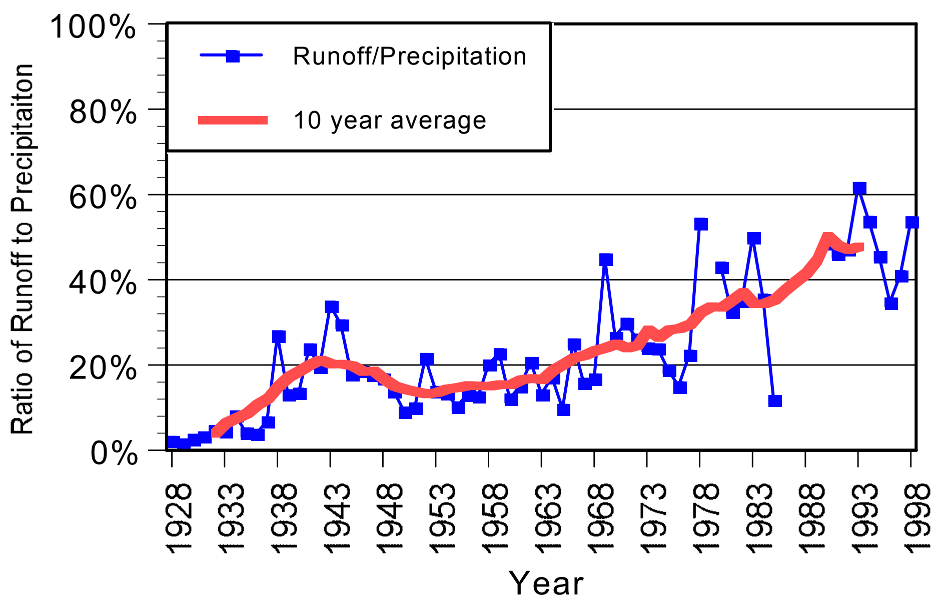

Figure 2-7. The Ratio of Annual Runoff in the Los Angeles River Measured at Firestone Blvd. to the Annual Precipitation at the Los Angeles Civic Center from 1928 to 1998
Source: Western Regional Climate Center and L.A. County Department of Public Works. Reprinted from Dallman and Piechota 1999.

CURRENT CONDITIONS

California, 25 percent of all known plant species in North America can be found, and Southern California supports half of all California's habitat types (Mayer and Laudenslayer 1988). The Mediterranean ecosystem type (which predominates adjacent to the coastal mountains in Southern California) exists on only 3 percent of the earth's land surface. Worldwide, it is more threatened than the rainforest.

■ Historical Conditions

The major native vegetation communities in the region include chaparral, grasslands, coastal sage and alluvial scrub, oak woodland, oak savanna, riparian and conifer forest. Alluvial scrub and chaparral were the most widespread in the foothills and basin, and conifer forests dominated the higher elevations. Many mixed communities and locally unique habitats resulted from the topography and varying microclimates. These conditions allowed the development of unique species and subspecies of plants and animals, giving the region a rich biodiversity. Both the San Gabriel and Los Angeles rivers supported extensive riparian habitats containing marsh grasses, willow, cottonwood, mulefat and sycamore. The rivers provided steelhead trout habitat. The basin and surrounding hills also supported large predators, such as grizzly bear and mountain lion. Although the grizzly bear appears on the state flag and was once abundant throughout the state, the last known grizzly bear in California was killed in 1922.

■ Existing Conditions

The continued existence of native vegetation and plant communities in the watersheds is generally impacted by urban and suburban development. Native vegetation in much of the basin has been displaced by development, but large expanses of chaparral, oak woodland, California walnut woodland, and coastal sage scrub remain in the Santa Monica and San Gabriel Mountains and in the Verdugo Hills. Alluvial scrub is found in Big Tujunga Wash above Hansen Dam and above the Santa Fe Dam in the San Gabriel Valley. Grasslands occur in the undeveloped valleys and hillsides of northern Los Angeles County and in the Puente Hills. Conifers, primarily Big Cone Douglas Fir, White Fir, Lodgepole Pine, and Ponderosa Pines, are confined mostly to the Angeles National Forest in the San Gabriel Mountains.

Riparian corridors occur along streams in the San Gabriel Mountains and the upper and middle reaches of the San Gabriel River, including Walnut and San Jose Creeks, and upper Los Angeles River watershed, including the Santa Monica Mountains, Simi Hills, Verdugo Mountains and Santa Susana Mountains. Freshwater stream habitat also occurs in the upper San Gabriel River and streams in the San Gabriel foothills, Puente and Chino Hills, the Whittier Narrows, and the Glendale Narrows on the Los Angeles River. Wetlands occur in limited areas, mostly near the coast. The estuaries of both rivers provide habitat for fish and a variety of birds.

Urban development has also encroached upon wildlife habitat, displacing large mammal populations, particularly in the basin. The mountain and foothill areas still support important mammal species, including mountain lion, bobcat, black bear, bighorn sheep, gray fox, coyote, American badger, and mule deer. Some wildlife species, particularly deer, raccoon, and coyote, can be found in suburban areas, occasionally wandering into backyards, creating a potential for conflict between people, pets and wildlife. The rare encounters between humans and mountain lion or bear usually turn out to be deleterious to the animals. Ecosystem health depends upon preserving both large habitat blocs and linkages between those blocs, so that predator and prey species can survive in balance and so that undesirable interactions between wildlife and people are minimized.

■ The Effect of Exotic Species

Although the watersheds support approximately 450 species of birds, small populations of large mammals, and dozens of species of small mammals, reptiles and amphibians, agriculture and cattle grazing in the 19th century and urban development in the 20th century have significantly altered the native ecology. California's mild climate allowed the introduction of a wide range of exotic species.

Native plant species have been largely replaced in the basin by landscaping associated with urban and suburban development. In undeveloped areas, non-native plants such as arundo *(Arundo donax)*, tree tobacco (*Nicotiana glauca*), castor bean (*Ricinus communis*), salt cedar (*Tamarix ramosissima*) and *Senecio mikanioides* are out-competing native species because they are not edible to wildlife or lack natural predators such as disease and insects. Arundo, a tall bamboo-like grass that is prolific and difficult to eradicate, is probably the most invasive exotic species. In riparian areas, it takes up large amounts of water, crowds out native plants, clogs streams, and disrupts the balance for aquatic species. Along the Whittier Narrows, arundo covers about 80% of the landscape.

The alteration of the basin landscape from grasslands to urban metropolis caused a decline in larger birds such as owls and raptors, which allowed some native species such as crows and mockingbirds to flourish. These in turn have crowded out many species of songbirds. Introduced species such as the European starling have also displaced some native species. In suburban areas, domestic cats and dogs have introduced disease and contributed to reduced populations of birds and small mammals as well. In riparian areas, introduced species of fish such as mosquito fish (G*ambusia sp.*), crayfish, and bullfrogs have impacted native populations of fish and amphibians.

■ High Quality Habitat Areas

The upper San Gabriel River basin and portions of the upper Los Angeles River watershed support high quality riparian habitat and oak woodland. Riparian areas in the Whittier Narrows reach of the San Gabriel River and along the soft-bottom portions of the Los Angeles River contain freshwater marsh communities and riparian forest, although non-native species are increasingly prevalent. Lower Compton Creek, above its confluence with the Los Angeles River, includes several miles of freshwater marsh. These riparian habitats support hundreds of species of birds, dozens of native plants, and a variety of mammals and reptiles. Native fish species vary. The upper San Gabriel River and the creeks in the mountains and foothills support trout and Arroyo Chub (*Gila orcutti*). The Santa Ana sucker (*Catostomus santaanae*) and Santa Ana speckled dace (*Rhinichthys osculus*) are found in the upper reaches of the San Gabriel River and Big Tujunga Creek.

In the foothills and throughout the basin, patches of natural or nearly natural habitat of varying size remain, supporting native species of plants and animals. These are most prevalent in regional parks, recreation areas and other protected areas, but there are also significant natural areas that are not yet protected. The largest intact areas of wildlife habitat occur in the Angeles National Forest, the Santa Monica Mountains, Verdugo Mountains, San Rafael Hills, Simi Hills, Santa Susana Mountains, Santa Fe Dam floodplain, Sepulveda Basin, and Whittier Narrows recreation areas, and in the San Jose and Puente Hills.

2. Species Management

■ Threatened and Endangered Species

The Federal Endangered Species Act, passed in 1973, defined categories of "endangered" and "threatened" species and required all federal agencies to undertake programs for the conservation of endangered and threatened species, and prohibited agencies from authorizing, funding, or carrying out any action that would jeopardize a listed species or destroy or modify its "critical habitat." The California Endangered Species Act (CESA) generally parallels the main provisions of the Federal Endangered Species Act, although limited to species or subspecies native to California. Under CESA the term "endangered species" is defined as a species of plant, fish, or wildlife that is "in serious danger of becoming extinct throughout all, or a significant portion of, its range." In general, both the Federal and California laws are designed to identify and protect individual species that have already declined in number significantly.

Southern California has the second greatest number of endangered and threatened species nationwide, after Hawaii, and the majority of these species are not found outside of California. Within the watersheds, there are hundreds of endangered, threatened, and sensitive species, mostly plants (see Appendix G). Federal critical habitat designations for two animals, the threatened California gnatcatcher (*Polioptila californica*) and the endangered arroyo toad (*Bufo microscaphus californicus*), fall within the watersheds (**Figure 2-8**).

The endangered steelhead trout (*Oncorhynchus mykiss)* once traversed the entire length of the Los Angeles and San Gabriel Rivers, and other coastal streams. Although the southern boundary of its range is officially designated as Malibu Creek, steelhead have recently been found in Topanga Creek (the next drainage east) and in San Mateo Creek in San Diego

County. The National Marine Fisheries Service, the federal agency in charge of the listing, recently proposed extending the boundary to include San Mateo Creek. This would not include the intervening streams unless steelhead were found to inhabit them. Steelhead are the only native Southern California species that travel the waters from the mountains to the sea and back. If conditions are appropriate for steelhead, they are generally appropriate for many other species as well.

Steelhead Trout Caught Below Glendale in 1940

■ Exotics Removal

Because arundo's extensive root system allows it to resprout rapidly, eradication programs have increased in recent years, utilizing mechanical removal methods, hand clearing, and herbicides. The Forest Service is the lead agency for "Team Arundo," an interagency group conducting arundo eradication efforts in Southern California. Los Angeles County, local conservancies, and conservation groups have also undertaken smaller-scale eradication programs throughout the watersheds. The key to permanent eradication is to start from the top of a watershed, since arundo cleared downstream will likely reestablish itself if there are occurrences upstream. However, significant progress has been made in removing the reed and restoring native vegetation along many stream reaches.

Arundo Removal

Several other invasive plant control programs are underway to manage lesser-known species. Alligator weed (*Alternanthera philoxeroides*) and water hyacinth (*Eichhornia crassipes*), for example, occur in streambeds throughout the Los Angeles County, affecting nearly 5,800 acres. Management efforts for alligator weed have been ongoing since 1956, and coverage of the weed is fairly low and under control. A program of biological control of water hyacinth using exotic natural enemies began in 1988. The coverage of water hyacinths is high and increasing. These programs are conducted jointly by the California Department of Food & Agriculture, the U.S. Army Corps of Engineers, and Los Angeles County Department of Agriculture.

Non-native plant species occurring in grasslands and disturbed land areas are numerous, and include klamathweed (*Hypericum perforatum*), puncturevine (*Tribulus terrestris*) and yellow starthistle (*Centaurea solstitialis*). The percentage of cover is low, but they occur throughout the county. Biological control programs for these species began in 1988, conducted by Los Angeles County Department of Agriculture and California Department of Food & Agriculture. Klamathweed and puncturevine are considered to be under control but coverage of yellow starthistle is increasing. All are monitored through periodic aerial surveys.

3. Habitat Management

■ Significant Ecological Areas

Habitats that support rare or sensitive species of plants and animals occur throughout the watersheds. In 1980 Los Angeles County designated certain habitats as Significant Ecological Areas

(SEAs) in the County's General Plan (**Figure 2-8**). These include the habitat of rare, endangered and threatened plant and animal species, biotic communities that are restricted in distribution, habitat that is important to the life cycle of a species or group of species, biotic resources that are of scientific interest, are important to game species habitat or fisheries, or are relatively undisturbed. Although SEAs are not off-limits to development, they do have some restrictions, and potential development requires additional environmental review in order to protect the identified sensitive resources. SEA boundaries have been proposed for revision and expansion in 2001.

■ Natural Community Conservation Planning

The State of California's Natural Community Conservation Planning program began in 1991, with an objective to conserve natural communities at the ecosystem scale while accommodating compatible land uses. The program seeks to focus on the long-term stability of wildlife and plant communities.

The focus of the initial effort is the coastal sage scrub habitat of Southern California, home to the California gnatcatcher and approximately 100 other potentially threatened or endangered species. This much-fragmented habitat is scattered over more than 6,000 square miles in Southern California, including the southeastern corner of Los Angeles county and large areas of Orange County. Other habitats may warrant designation, delineation, and development of conservation plans, including riparian and valley oak woodland, both of which are found in the watersheds.

4. Habitat Linkages

Urban and suburban development not only reduces total habitat area, but also creates barriers to movement of wildlife between habitats, through

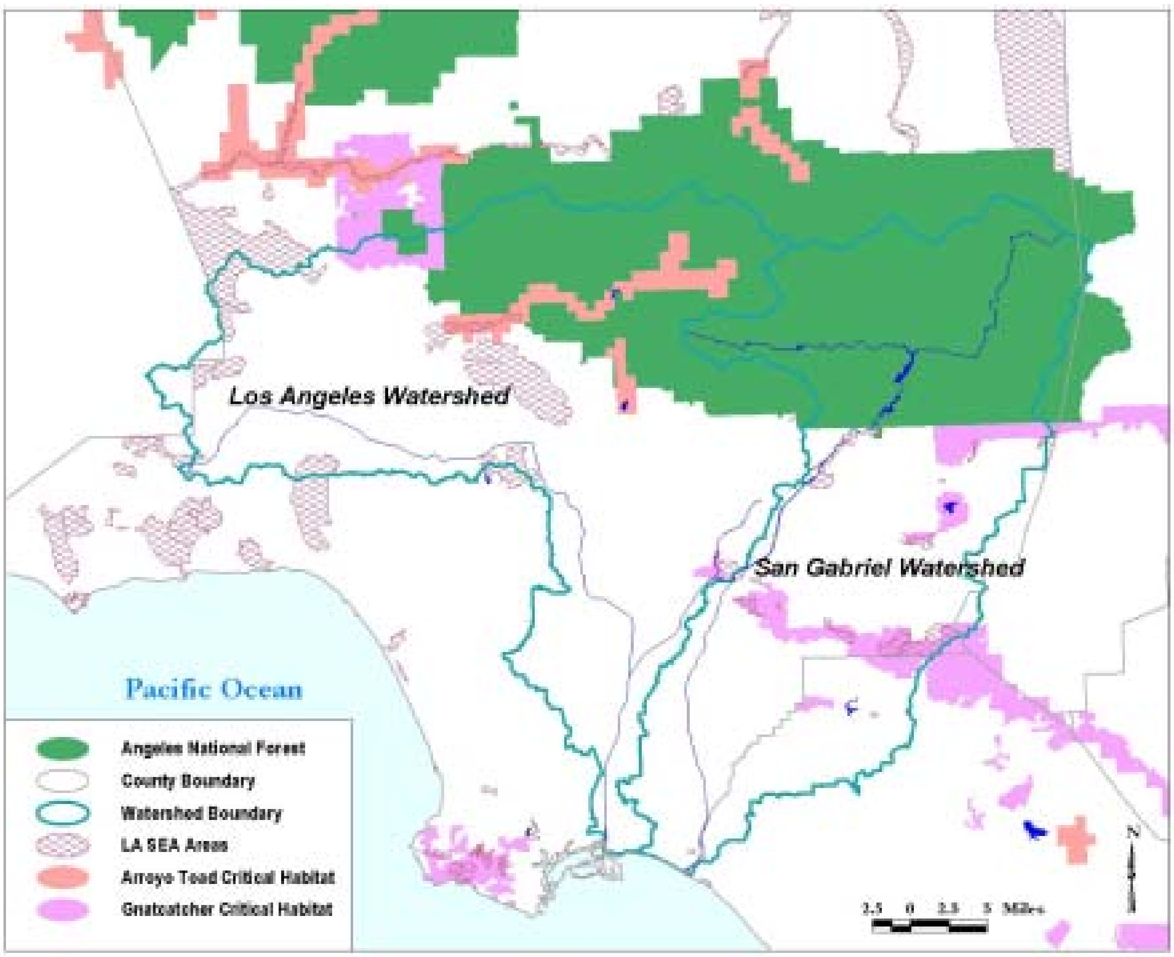

Figure 2-8. Significant Ecological Areas and Critical Habitat Designations

installation of freeways, dams, and backyard fences. Both loss of habitat and habitat fragmentation can reduce plant and animal populations and species diversity. As large habitat areas disappear, connections between patches of habitat become increasingly important to maintaining plant and animal populations.

Urban Ecological Integrity

Historically, urban design has focused on aesthetics and efficiency: how to get from place to place easily and safely. Because of this focus on human systems and the built environment, natural systems, including plant communities and wildlife habitat, have typically not been considered. In recent years, the concept of ecological integrity (e.g., maintaining the integrity of an environmental system, such as an ecosystem) has begun to be considered in urban design. Using case studies in wildlands, the field of conservation biology has established principles for maintaining biodiversity and ecological integrity that can be applied to urban and suburban settings with minimal modification. These principles include:

- *Species that are well distributed across their native range are less susceptible to extinction than species confined to small portions of their range.* Maintaining multiple populations of imperiled species maintains a natural range of genetic variability and reduces the chance that environmental variability will result in species extinction. For urban settings, this means that habitat protection must have some redundancy. Species associated with a particular habitat must be represented in many places across the urban landscape, both within and among metropolitan areas, so that extinction at one location does not eliminate the species entirely from the urban setting.
- *Large blocks of habitat, containing large populations, are better than small blocks with small populations.* All else being equal, larger populations are less susceptible to extinction. This is especially true when habitat patches are isolated from each other, which is typical in urban landscapes. Many species of forest and grassland birds, for example, are progressively more likely to be found as habitat area increases. Some species are present only in large blocks of habitat. This is recognized as species-area relationship: species richness increases as habitat area increases. Therefore, larger blocks of natural or semi-natural habitat should be priorities for protection.
- *Blocks of habitat close together are better than blocks far apart.* Blocks of habitat close together may function as one larger, contiguous habitat block for those species that can move between areas. What constitutes "close together" depends on the species of concern. Habitats close together for birds might be inaccessible for animals incapable of crossing intervening barriers. For example, many small mammals, salamanders, and flightless invertebrates seldom or never cross roads.
- *Habitat in contiguous blocks is better than fragmented habitat.* Habitat fragmentation has been documented to have harmful effects in studies worldwide, although considerable regional variability exists. Natural and semi-natural habitats in urban landscapes are typically fragmented. Although the thresholds of fragmentation (where ecological integrity unravels) cannot be reliably determined, the less fragmentation, the better.
- *Interconnected blocks of habitat are better than isolated blocks.* Connectivity allows organisms to move between patches of habitat. A collection of small areas may be individually too small to maintain populations of some species. But if connected, those small areas may provide sufficient habitat for a species to maintain viable populations. The whole can be greater than the sum of its parts.

Urban Wildlife Connectivity

Wildlife corridors are currently a popular concept in conservation planning. However, without rigorous investigation of potential utility or consequences, linkages drawn on maps may have limited value in maintaining species diversity. Linkages and corridors must be defined in terms of functional connectivity: (1) providing for daily and seasonal movements of animals; (2) facilitating dispersal, gene flow, and rescue effects (for animals or plants); (3) allowing for range shifts of species (i.e., in response to climate change); and (4) maintaining flows of ecological processes (e.g., fire, wind, sediments, water).

Because small patches of natural and semi-natural habitat in urban areas are incapable of supporting populations of many species, maintaining connectivity is necessary to maintain a rich diversity of wildlife. Connectivity is generally species-specific and landscape-specific. What is a corridor to one species may be a barrier to another. Linkage planning efforts should focus on species that are particularly sensitive to habitat fragmentation. In order to plan effective corridors, additional research is needed about the mobility of species, and what constitutes potential barriers to their movements. The appropriate width of a corridor is highly variable and depends on the nature of the surrounding habitat, the characteristics of the species involved, the length of the corridor, and other factors. Creating effective underpasses or tunnels to allow animals to cross safely beneath or over roads poses the greatest challenge.

To gauge the success of habitat linkages, specific animal and plant species can serve as sensitive indicators of functional connectivity. A list of potential indicator species for the watersheds is provided in Appendix H.

Wildlife corridors may also constitute important habitats in their own right, particularly when they are located in riparian areas. In the arid West, riparian areas typically are the most species-rich habitats. Some 80% of vertebrate species in Arizona and New Mexico depend on riparian habitat for at least a portion of their life cycles (Johnson 1989 in G. Macintosh, ed. *Preserving Communities and Corridors*, Defenders of Wildlife). Maintaining intact riparian areas not only contributes to terrestrial ecological integrity, but may also increase aquatic biotic integrity. However, riparian protection alone may not improve stream communities.

In urban areas, most wildlife corridors will also be corridors for people. Urban greenways typically have trails and are used for recreation and other purposes, thus urban greenways must be designed with the needs of both people and wildlife in mind. A recent urban trail handbook (*Planning Trails with Wildlife in Mind*, 1998, Colorado State Parks and Hellmund Associates) includes some useful recommendations: route trails around edges of high-quality habitat patches; do not route trails continuously close to riparian areas; and balance competing wildlife and recreation needs across a landscape or region rather than trying to accommodate all uses within specific areas. These recommendations underscore the need for biologists to be involved in the early stages of greenway planning and the trail development process.

Urban to Wildland Networks

Southern California is distinctive in having major urban centers directly adjacent to wildlands (e.g., the San Gabriel and Santa Monica Mountains, and the various foothills). In the long run, many wildlife species will persist in these urban areas only if there are connections to the surrounding rural and wildland landscapes. An appropriate hierarchy of connected habitat networks would include: (1) relatively small habitat patches and narrow corridors within the densest urban zone; (2) a network of larger habitat patches and wider corridors in suburban and rural areas, as well as in a few areas within the urban matrix (e.g., Puente Hills and Griffith Park); and (3) the wildland landscape (e.g., the national forests), with large habitat patches, low road density, and greater overall connectivity.

There are two potential problems with this "network of networks" design. One, corridors leading from the more developed zones of the network might funnel exotics and other opportunistic, invasive species into wildland areas. Roads and roadsides, for example, are frequent avenues for the invasion of these pests. Well-designed corridors, especially if wide, may provide habitat for predators of some animal species (e.g., feral cats, opossums). In addition, corridor bottlenecks could be used to trap those species and limit their spread.

A potentially more serious concern is for corridors connected to wildlands or rural areas to provide a route for large mammals (such as deer) into suburban and urban areas. Many residents like to see deer near their homes, but are unhappy when deer eat their gardens. Predators may also use corridors to follow their prey. This will require careful consideration of options and consequences, to achieve an appropriate balance between the need for species mobility and the need to minimize human and animal conflicts.

Identification of potential habitat linkages within the watersheds is provided in Chapter 3, A Vision for the Future.

D. OPEN SPACE AND RECREATION

1. Definition of "Open Space" and "Recreational" Land Use

Generally speaking, open space may be any land that is not developed for urban use. This may include natural areas set aside for species protection, lands used for agriculture or natural resource extraction, recreational areas, or areas unsuitable for development either due to a potential hazard (such as slide areas or floodplains) or due to other uses such as groundwater recharge or flood protection. In this document, open space implies areas that are in a reasonably natural state and that can serve as wildlife habitat in addition to public access for passive forms of recreation.

Recreational use may be designated active, passive, or both. Passive use refers to activities that are generally low impact such as hiking, fishing, picnicking, bird watching, or non-motorized boating. Active recreational use may include facilities designed for sports such as soccer or baseball, lakes for motorboats and jet skis, bicycle trails or equestrian trails.

2. Existing Open Space and Recreational Areas in the Watersheds

The San Gabriel and Los Angeles watersheds include a variety of areas devoted to recreation in some form, often in conjunction with the preservation of natural open space. These include the federal, state, joint powers authority lands, and an assortment of regional and local parks, nature centers, and preserves. Parks and open space are not evenly distributed throughout the region, and access for those without private transportation is beginning to be addressed by several agencies.

Table 1. Agencies Administering Open Space and Recreational Areas

Type	*Agency*
Federal	U.S. Forest Service
	U.S. Army Corps of Engineers
	Bureau of Land Management
	National Park Service
State	Department of Parks and Recreation
	Santa Monica Mountains Conservancy
Joint Powers Authorities	Mountains Recreation and Conservation Authority
	Puente Hills Native Habitat Preservation Authority
Counties	Parks and Recreation
	Department of Public Works
Cities	Parks and Recreation Departments, School Districts

■ Federal Lands

The Angeles National Forest is one of the most visited forests anywhere in the country, with an estimated thirty million visitors annually (Cook 2001). Within the watersheds, the forest accounts for 23 percent of the total land area. The Forest's 691,539 total acres include 8,708 water surface acres in twenty-five lakes and reservoirs, 110 picnic areas and campgrounds, and 557 miles of hiking trails. There are also a number of special use areas in the Forest that occur within the watersheds, described in the table below.

Seal Beach National Wildlife Refuge, within the Seal Beach Naval Weapons Station, is managed by the U.S. Fish and Wildlife Service. The Refuge contains 911 acres of natural coastal habitat, including salt marsh and tidal wetlands. It is home to the California least tern (*Sterna antillarum browni*), a federally listed endangered bird, and many other seabirds. Public access is restricted to a wooden trail leading

Table 2. Special Designations within the Angeles National Forest

Name	*Area*	*Designated*	*Purpose*
San Gabriel Wilderness Area	36,118 acres	1968	Wilderness designation—no development or permanent structures
Sheep Mountain Wilderness Area	43,600 acres	1984	Wilderness designation—no development or permanent structures
San Dimas experimental forest (UNESCO Biosphere Reserve)	17,163 acres	1933	Research and pilot testing of integrated forest management techniques; access by permit only.
Fern Canyon Natural Research Area	1,360 acres	1972	No development or permanent structures; near pristine condition. Contained within San Dimas Experimental Forest

to an overlook of the area, and is open a limited number of days to reduce disturbance to the wildlife.

State and Regional Facilities

California Department of Parks and Recreation, the Santa Monica Mountains Conservancy, Los Angeles and Orange County parks departments and other agencies manage substantial land acreage devoted to open space reserves, nature centers, botanical gardens and recreation areas. The chart below lists some state and county facilities and large regional facilities that may be managed by cities or multiple jurisdictions. Golf courses and local city parks are not included as they are too numerous, although their total acreage watershed-wide is substantial.

3. Access along the River Fronts

In the canyons of the San Gabriel and Santa Monica Mountains and the local hills, there is ample access to streams for fishing, swimming, and picnicking. A five and a half mile stretch of the West Fork of San Gabriel River is a "catch and release" area for native rainbow trout.

Within the urban core, access to the Los Angeles River is provided via pocket parks in the community of Elysian Valley. In addition, the City and County of Los Angeles are making progress on converting the maintenance road next to the river into a bikeway. The LARIO trail provides bicycle and equestrian access along the Rio Hondo and Lower Los Angeles River, as does the bicycle trail above the San Gabriel River channel. Concerns over public safety during periods of high stream flows or potential flash-flood conditions have left much of the urban rivers inaccessible or off-limits to the public. The potential for more riverside parks, walking trails and bike paths is increasing, as evidenced by the three-year old Bosque del Rio Hondo and new parks in Bell Gardens, Paramount and Maywood.

Table 3. Major Open Space and Recreational Facilities within the Watersheds

Type	*Name and Location*	*Acreage*	*Management*
Botanical Gardens	Arboretum of Los Angeles County, Arcadia	127	LA County
	Rancho Santa Ana Botanical Garden, Claremont	106	Private
	Descanso Gardens, La Canada	160	LA County
Parks and Recreation Areas	Frank G. Bonelli Regional Park, San Jose Hills	1,980	LA County
	Griffith Park, Los Angeles	3,481	City
	El Dorado Regional Park, Long Beach	520	City
	Elysian Park, Los Angeles	584	City
	Hahamonga Watershed Park, Pasadena	836	City
	Hansen Dam, Los Angeles	1,289	City, U.S. Army Corps
	Marshall Canyon County Park, Claremont	690	LA County
	Mulholland Gateway Park	1,200	SMMC
	Ralph B. Clark Regional Park, Fullerton/Buena Park	105	Orange County
	Santa Fe Dam Recreation Area	836	LA County
	Schabarum Regional Park, Puente Hills	500	LA County
	Sepulveda Dam Recreation Area	1,040	LA City /Army Corps
	Ted Craig Regional Park, Fullerton/Brea	124	Orange County
	Whittier Narrows Recreation Area	1,400	LA County
	Verdugo Mountains State Park	251 1,101	State Parks SMMC
Nature Centers and Wilderness Parks	Eaton Canyon Natural Area	184	LA County
	Claremont Hills Wilderness Area	1,220	City/LA County
	Deukmejian Wilderness Park	720	Glendale
	Eastern Rim-of-the-Valley Open Space	1,000	SMMC
	El Dorado Nature Center	130	Long Beach
	San Dimas Canyon Nature Center	1,000	LA County
	Simi Hills/Santa Susana Open Space	4,000	SMMC
	Whittier Narrows Nature Center	419	LA County

4. Trail Systems

Trails provide access for hiking, equestrian use and bicycling. There are hundreds of miles of trails of various types throughout the watersheds.

■ Types of Trails

In the Angeles National Forest, there are several trails that are part of the National Trails System, that was established in 1968. These include 176 miles of the Pacific Crest Trail and National Scenic trails, and 73 miles of National Recreation Trails, which provide for hiking and equestrian use. Trails in the Forest are open to mountain bikes as well, except for those in the National Trails System and those in the Wilderness areas. The Rails to Trails Conservancy, which converts unused railroad right-of-way to trails, has two trails in the region: Mt. Lowe Railroad Trail and the Duarte Bike Trail.

In the urban area, there are local and regional trails for bicycle commuting and recreation, walking, hiking and equestrian use. Approximately 500 miles of bike paths and bike lanes exist in Los Angles County currently. Bikeways are under development along the Los Angeles River and Arroyo Seco. Bike trails run along the Lower Los Angeles River, Coyote Creek, the Rio Hondo, and along the San Gabriel River from the Pacific Ocean at Seal Beach to the foothills of the San Gabriel Mountains.

■ Trail Connectivity

Connectivity between cities and parks exists in some areas but there are many local trails that do not extend beyond jurisdictional borders. The five regional parks in the San Gabriel Valley—Bonelli, Whittier Narrows, Santa Fe Dam, Marshall Canyon, and Schabarum—are connected by a trail system. Bicyclists, hikers, and equestrians use this trail, maintained by Los Angeles County. In May 2001, the Metropolitan Transit Authority recommended $21.6 million in funding over the next three years for thirteen bicycle trail projects that will expand and connect existing trails and add commuter bike lanes on city streets. The 28-mile LARIO trail, recently upgraded by Los Angeles County, provides connections to eight parks along the Rio Hondo and Los Angeles River.

The Rim of the Valley Trail encircles the upper Los Angeles River watershed and aims to connect the Santa Monica and San Gabriel Mountains. The National Park Service has begun marking the Juan Bautista de Anza National Trail through the region, and markers and interpretive signs can now be seen along the Los Angeles River. The Griffith Park to El Pueblo Trail will lead visitors from the park to downtown. Additional study is needed to determine how best to further connect existing trails within the watersheds.

5. Designated Scenic Highways and Vistas

Scenic highways include the Mulholland Scenic Parkway in the eastern upper Los Angeles River watershed. Caltrans is actively working towards obtaining federal scenic byway status for the Arroyo Seco Parkway (Pasadena Freeway). Federal designation can potentially bring in planning and implementation funding for both sides of the parkway.

Vista points in the watersheds include Grand View in Elysian Park, which provides views to downtown, Montecito Heights, Mount Washington, Taylor Yard, the Los Angeles River, and the Arroyo Seco. Sites within the Kenneth Hahn County Park in the Baldwin Hills, and new adjacent areas recently purchased, provide 360-degree views including to the ocean and downtown. At the Top of Topanga, visitors can view the San Fernando Valley as well as central Los Angeles. From Mulholland Scenic Parkway, a number of places provide views of the Los Angeles River Watershed and smaller coastal watersheds. These include Hollywood Bowl Overlook, Universal City Overlook, Nancy Hoover Pohl Overlook, and Summit Overlook. Many of the turnouts along the Angeles Crest Highway and campgrounds within the Angeles National Forest also provide spectacular views.

E. WATER SUPPLY

1. Sources of Water

Early settlements in the watersheds relied on surface water from springs, rivers, creeks, and lakes for drinking water and irrigation. In the 1870s, groundwater became an important additional water source as well-drilling technology improved. Water needs of the population have exceeded the available local supply for nearly a century. The combination of population growth and extensive use of non-native plants place demands on water supplies. Current sources of water for the basin include the following:

1. imported water from the Colorado River, the Owens Valley in Eastern California via the Los Angeles Aqueduct, and Northern California via the California Aqueduct;
2. local groundwater supplies;
3. recycled water from wastewater treatment facilities; and
4. surface water from local streams and the upper San Gabriel River.

While these supplies currently sustain a population of over seventeen million people in Southern California, they are subject to both seasonal and long-term variability depending upon climatic conditions throughout the source areas. During drought periods, there may be less water available for importation so groundwater use increases. During wet years, stormwater runoff and surplus imported water may be stored in reservoirs and groundwater basins for future needs. **Figure 2-9** depicts the average amount contributed to the region's water supply by each source. The percentage of groundwater and imported water varies from year to year, depending on hydrologic conditions. Groundwater contributes from 30 to 40 percent, while imported water may range from 56 to 66 percent of the total supply.

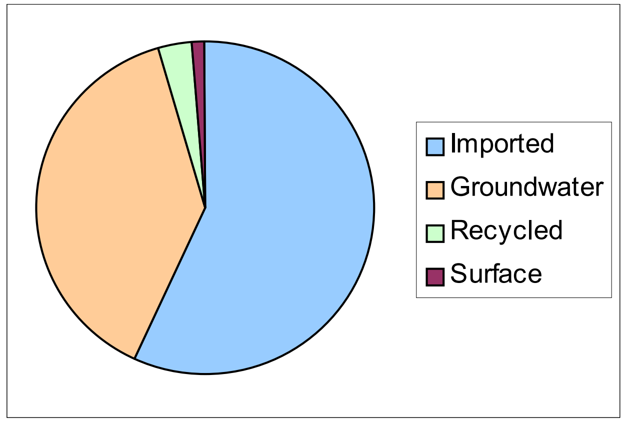

Figure 2-9. Sources of Water Supply
Source: Metropolitan Water District of Southern California (cited in Los Angeles & San Gabriel Rivers Watershed Council, in press)

2. Groundwater

The coastal plain is composed primarily of deep layers of marine sediments and eroded sediments washed down from the surrounding mountains. In some areas these sediments are over 30,000 feet thick. This geology has allowed for the storage of water in underground basins, or aquifers. Aquifers are not underground lakes, but places where the rock or soil is porous enough to trap significant amounts of water. There are eight major groundwater basins underlying the watersheds in the San Gabriel Valley, San Fernando Valley and the coastal plain (**Figure 2-10**). A cross section for the Los Angeles Coastal plain is illustrated in **Figure 2-11**. The contribution of groundwater basins to local water supply varies. The San Fernando basins represent 15–20 percent of the water supply for Burbank, Glendale, San Fernando, and Los Angeles, while the Raymond Basin provides 46 percent of the water supply for the City of Pasadena.

Recharge Programs

Water supply is increased through artificial or enhanced infiltration to replenish groundwater and compensate for the loss of natural permeability in the region. Surface water was "stored" in groundwater basins as early as 1895. Water is stored in facilities called spreading basins, in areas where soils

Table 4. Capacity of Local Groundwater Basins

Geographic Regions and Underlying Groundwater Basins	*Surface Area (acres)*	*Current Average Annual Yield (AF)**	*Estimated Total Capacity (AF)*
Los Angeles Coastal Plain: Central and West Coast basins	288,000	281,835**	20,300,000
Orange County Coastal Plain Basin	224,000	350,000	1,000,000
Raymond Basin	25,000	35-40,000	250,000
San Fernando Valley: San Fernando, Verdugo and Sylmar basins	327,000	105,000	500,000
Main San Gabriel Basin	106,880	200,000	8,600,000

*AF = Acre-foot, approximately 326,000 gallons of water
**Allowable under adjudication
Source: Assoc. of Ground Water Agencies, 2000

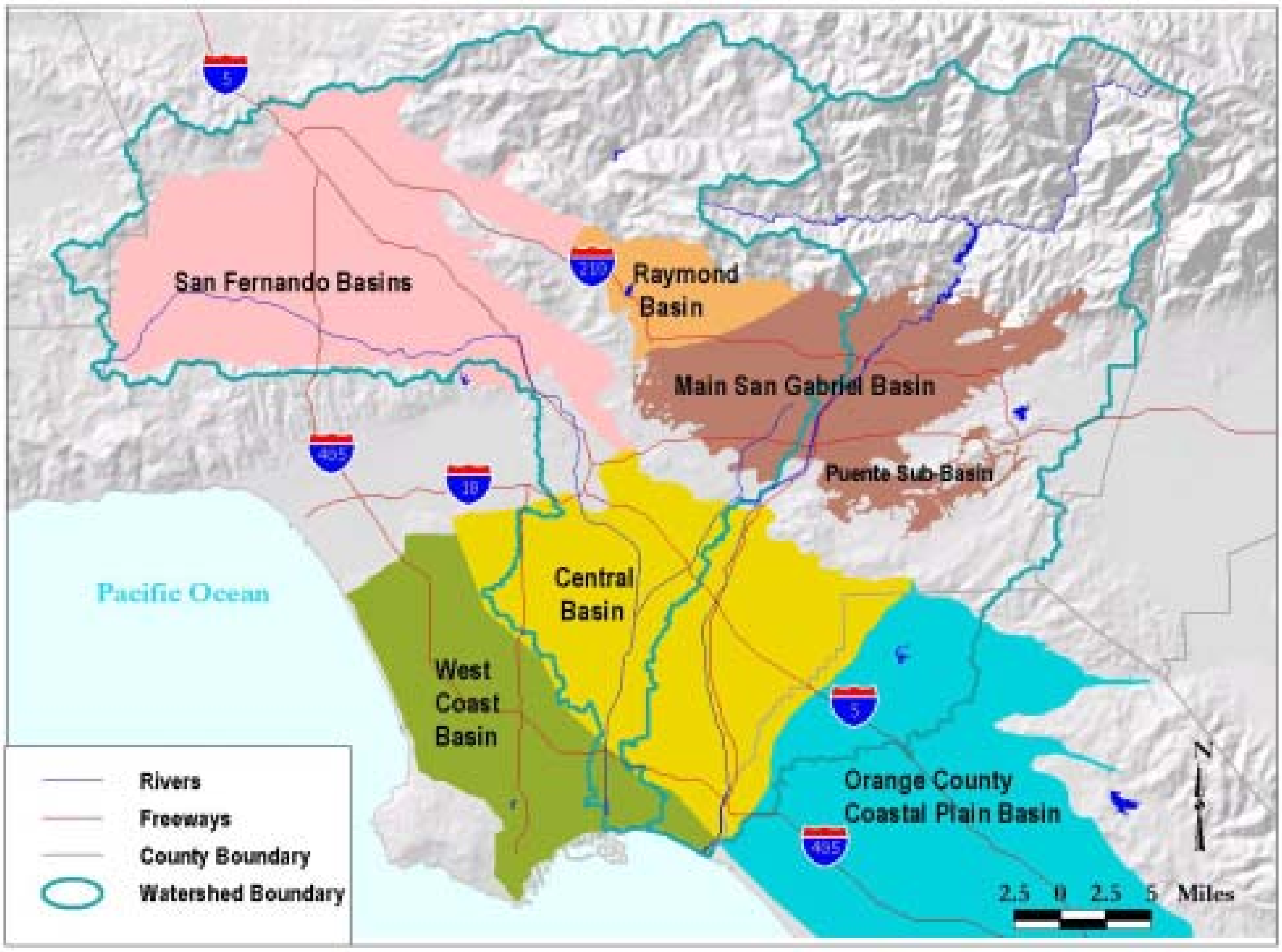

Figure 2-10. Groundwater Basins Underlying the Watersheds
Adapted from San Gabriel Watermaster and Montgomery Watson Harza

are very permeable and groundwater aquifers are connected to the surface or accessible through wells.

A total of 3,361 acres of spreading grounds exist in Los Angeles County in 32 separate locations, the majority of which are operated by the Los Angeles County Department of Public Works (LACDPW). Major facilities on the San Gabriel River include the San Gabriel Canyon spreading basin, Santa Fe Reservoir and the Montebello Forebay south of Whittier Narrows (Rio Hondo and San Gabriel spreading basins), and in unlined reaches of the

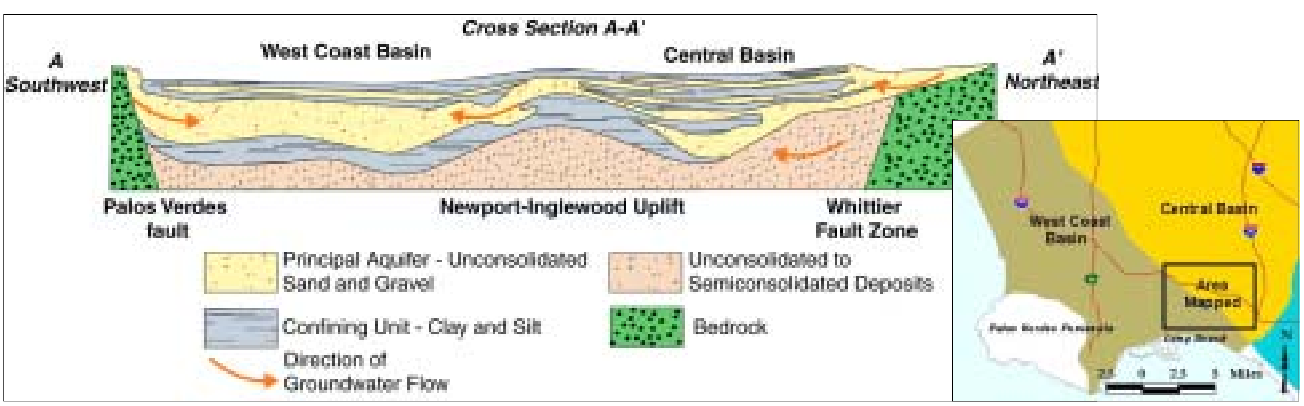

Figure 2-11. Cross-section of the Los Angeles Coastal Plain Groundwater Basin
Source: Association of Groundwater Agencies

river. Facilities in the Los Angeles River watershed include Pacoima and Tujunga Wash spreading basins, Hansen Dam in Sun Valley and Devil's Gate on the Arroyo Seco. In the 1998–99 water year, a total of 256,332 acre-feet of water were conserved through spreading grounds within the watersheds, as shown in Table 5.

Table 5. Water Recharged During the 1999–2000 Water Year (Acre-feet)

Location	*Reclaimed*	*Imported*	*Runoff*	*Other**	*Total*
San Gabriel Basin	0	50,953	76,792	5,055	132,800
SF Valley Basin	0	0	14,105		14,105
Coastal Plain	43,180	45,037	21,120		109,427
TOTAL	*43,180*	*95,990*	*112,107*	*5,055*	*256,332*

* Water owned by other local water agencies and stored in the San Gabriel Basin
Source: L.A. County Department of Public Works, Water Resources Division

■ Groundwater Management

The underlying groundwater basins are managed to ensure that water extraction from groundwater basins is in balance with water supply. Court decisions, called adjudications, have established the methods that water managers use in each basin. The court determines the groundwater rights of all the users who extract water, how much can be extracted, and appoints a manager or "watermaster." The watermaster ensures that the basin is managed according to the adjudication and reports periodically to the court.

In 1955, the Central and West Basin Water Associations were formed to manage groundwater pumping in their respective basins. By the late 1950s, groundwater pumping in the Central and West Coast Basins had reduced groundwater levels to historic lows. Saltwater from the Pacific Ocean began to increase the salinity in groundwater in the West and Central coastal basins. Many wells had to be abandoned due to seawater intrusion. Since then, the LACDPW, WRD, and other agencies have operated facilities that inject fresh water into the groundwater basins to help keep intruding saltwater out. Saltwater barrier facilities are located along the coast at Manhattan Beach, between Huntington Beach and Newport Beach, and at the mouth of the San Gabriel River at the Los Angeles and Orange County boundary.

In 1961 the Central and West Coast Basins were adjudicated to limit groundwater pumping in the basin and explore alternative water sources. While this decision had the effect of decreasing pumping, groundwater levels in many parts of the basin still remain below sea level. The Water Replenishment District of Southern California (WRD) manages the basins. The WRD is responsible for maintaining adequate groundwater supplies, reducing seawater intrusion into aquifers, and protecting groundwater quality.

Groundwater pumping in the San Gabriel groundwater basin began to exceed recharge rates in the 1950s, leading to a lengthy legal battle that was settled in 1972. This settlement established the San Gabriel River Watermaster to adjudicate water rights and manage groundwater resources in the Main San Gabriel Basin. The water resources of the groundwater basins in the Upper Los Angeles River Area (ULARA) are managed by an agreement made in 1973. This agreement balances the groundwater rights of the City of Los Angeles with the upstream cities of Glendale and Burbank. The ULARA Watermaster is responsible for managing groundwater supplies and protecting groundwater quality.

Because of groundwater extraction, seawater from the Pacific Ocean has increased the salinity in groundwater in the West and Central coastal basins. Many wells had to be abandoned in the 1940s due to seawater intrusion. Since the 1950s, the LACDPW and other agencies have operated facilities that inject fresh water into the groundwater basins to help keep intruding saltwater out. Saltwater barrier facilities are located along the coast at Manhattan Beach and at the mouth of the San Gabriel River at the Los Angeles and Orange County boundary.

3. Imported Water

Water is imported into Los Angeles County from the Owens Valley on the eastern slope of the Sierra Nevada, from Northern California and from the Colorado River.

Construction of the first Los Angeles Aqueduct from the Owens Valley began in 1908. Under the supervision of William Mulholland, this 233-mile aqueduct was constructed in five years. In 1940 the aqueduct was extended 105 miles north to Mono Basin. A second aqueduct from Owens Valley was completed in 1970 to further increase capacity. Approximately 480,000 acre-feet of water are delivered to the City of Los Angeles each year. The amount the aqueduct delivers varies from year to year due to fluctuating precipitation in the Sierra Nevada. As a result of legal restrictions on water transfers to protect the source environment, future deliveries are expected to be reduced to an average of 321,000 acre-feet annually over the next twenty years.

The 242-mile Colorado River Aqueduct, completed in 1941 to deliver water to the Southern California coastal plain, has a capacity of 1.3 million acre-feet. Annually, California is allowed 4.4 million acre-feet of Colorado River water. California has traditionally received in excess of that amount when there is excess water available, in wet years or when other states drawing from the Colorado River do not use their full allotment. Future supplies from the Colorado River may be reduced due to competing demands. The Metropolitan Water District recently completed the Eastside Reservoir project, which created Diamond Valley Lake, to store 800,000 acre feet of Colorado River water.

The State Water Project (SWP) was created in 1960 to deliver water to regions of the state where resources are scarce. The SWP brings water 444 miles from the Sacramento-San Joaquin River Delta to Southern California via the California Aqueduct. The SWP has delivered up to 3.6 million acre-feet annually, although significantly less water is available during dry-year periods. One of the goals of the CALFED Bay-Delta Program is to improve water supply reliability for the Delta, therefore the potential for future increases in water supplies from the SWP for Southern California is uncertain.

4. Surface Water

While the rivers used to be the primary source of water for the basin, they now supply only a small percentage of the total. These local supplies have a very low cost in comparison to imported water, especially when the energy costs of transporting water are considered. Water from the upper San Gabriel River is stored in Cogswell, San Gabriel, and Morris Reservoirs. A portion is treated for municipal use with the balance used for groundwater recharge. The City of Pasadena obtains 40 percent of its municipal water supply indirectly from the Arroyo Seco and Millard Stream, by diverting a portion of the total flow into spreading basins adjacent to Devils Gate Reservoir.

5. Recycled Water

Recycled or reclaimed water is treated effluent from wastewater treatment facilities. This water is used primarily for irrigation, industry, injection into barrier wells to prevent saltwater intrusion, and groundwater recharge. Currently recycled water makes up only 3 percent of the annual water supply in the Los Angeles region, although its potential is far greater.

Conservation efforts over the past thirty years have kept total water demand from increasing in tandem with population. In the City of Los Angeles, population has increased over 35 percent since 1970, while water usage increased only 7 percent. However, competing interests for imported water and sustained population growth will continue to drive the need for increased water conservation and expanded use of recycled water.

F. WATER QUALITY

1. Responsibility for Managing Water Quality

Protection of water quality in California is primarily the responsibility of the State Water Resources Control Board (SWRCB) and, on a regional basis, the nine California Regional Water Quality Control Boards. The Porter-Cologne Water Quality Control Act (California Water Code) authorizes the State Board to adopt policies for all waters of the state and directs each Regional Board to prepare a Basin Plan to protect water quality. The water quality in the watersheds is primarily under the jurisdiction of the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB). The Santa Ana Regional Board has jurisdiction over a portion of the Coyote Creek subwatershed.

The California Department of Health Services also has responsibility to protect the quality of drinking water, in accord with California's Drinking Water Source Assessment and Protection Programs, in response to the 1995 reauthorization of the Federal Clean Water Act. The Water Replenishment District of Southern California (WRD) is also authorized under the California Water Code to engage in activities to protect groundwater in the Central and West Coast groundwater basins. The Main San Gabriel Watermaster and the ULARA Watermaster also have responsibility for water quality protection for their respective basins.

The Basin Plan for the Los Angeles Region was originally prepared in the 1970s and has been updated several times. The Santa Ana River Basin Plan was first adopted in 1975, with a major update in 1995. These plans address beneficial uses for surface waters in the region, as required by the Federal Clean Water Act, water quality objectives for protection of beneficial uses, and a plan for enhancing and maintaining water quality.

2. Beneficial Uses

State Board resolution 88-63 and LARWQCB resolution 89-03 state:

> "All surface water bodies and ground waters of the State are considered to be suitable, or potentially suitable, for municipal or domestic water supply and will be so designated by the Regional Boards…[with certain exceptions which must be adopted by the Regional Board]." (LARWQCB 1994)

Surface waters include rivers, streams, lakes, reservoirs, and wetlands. Beneficial uses defined by the Los Angeles Regional Board for surface waters in the watersheds generally include swimmable, fishable, industrial, non-contact recreation and wildlife habitat. Water bodies not meeting the water quality standard for their designated beneficial use are to be listed as "impaired." Beneficial uses defined by the LARWQCB for groundwater include municipal, industrial, agricultural, and aquacultural.

3. Water Quality Concerns

Because of the largely urban and industrial land uses throughout the watersheds, the surface and groundwater quality has been substantially degraded at many locations. The following section provides a brief description of the major water quality concerns for surface water and groundwater.

■ Surface Water

According to the Regional Board, "uncontrolled pollutants from non-point sources are believed to be the greatest threats to rivers and streams within the watershed" (LARWQCB 1994). Urban runoff and illegal dumping are considered to be major sources of pollution in the San Gabriel and Los Angeles River Watersheds. Point sources, such as sewage treatment plants and industrial operations discharging into the rivers, also contribute to pollutant loads. As required under §303(d) of the Federal Clean Water Act, specific surface water quality concerns have been identified for surface water bodies. California's most recent 303(d) list was approved in 1998 and contains 509 water bodies designated as impaired. EPA 303(d) listed surface water constituents of concern for the watersheds are shown in the table below.

For waters on the 303(d) list, and where the US EPA administrator deems they are appropriate, the states are to develop Total Maximum Daily Loads or TMDLs. A TMDL defines the total amount of a particular pollutant that is acceptable in the water body consistent with its designated beneficial use. Federal regulations require that each TMDL account for all sources of the pollutants that caused the water to be listed, both contributions from point sources (federally permitted discharges) and contributions from non-point sources. Impaired reaches of the San Gabriel and Los Angeles Rivers and their major tributaries are illustrated in **Figure 2-12**.

Table 6. Pollutants of Concern in the Watersheds

Drainage	*Algae*	*Ammonia*	*Chlorpyrifos*	*Coliform*	*Cadmium*	*Copper*	*Lead*	*Selenium*	*Zinc*	*Odors*	*Oil*	*Pesticides*	*pH*	*Toxicity*	*Trash*	*Volatile organic compounds*
San Gabriel	x	x		x			x					x	x	x	x	
Los Angeles	x	x	x	x	x	x	x	x	x	x	x		x		x	X

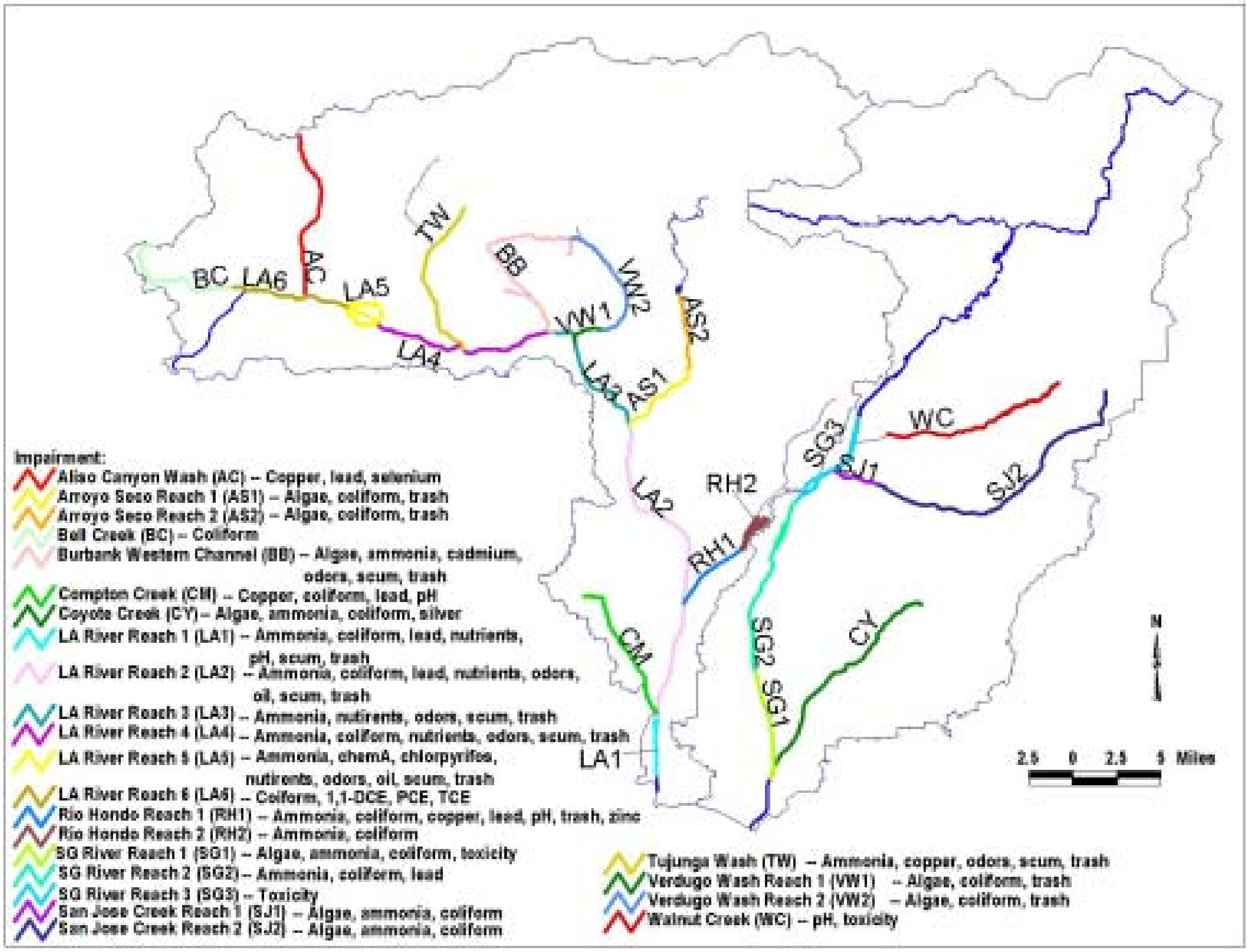

Figure 2-12. Impaired Reaches of the San Gabriel and Los Angeles Rivers and Tributaries
Source: Montgomery Watson Harza

■ Groundwater

As described earlier in this document, groundwater supplies most of the watersheds' local potable water supply. Specific groundwater quality concerns include volatile organic compounds, perchlorate, hexavalent chromium, and NDMA from industrial activities and nitrates from agricultural and septic tanks and leach fields. Low levels of hexavalent chromium have been detected in San Fernando Valley drinking water wells and in Central Basin aquifers. The United States EPA has designated portions of the San Gabriel and San Fernando basins as Superfund sites, and has initiated cleanup operations. Other Superfund sites have been identified within the watersheds, such as the Jet Propulsion Laboratory in La Cañada Flintridge, Lockheed in the San Fernando Valley and the Pemaco site in Maywood. Some water supply wells have been taken out of production where contaminant levels exceed drinking water standards. Efforts of local cities, water companies, and water agencies, such as the San Gabriel Basin Water Quality Authority, have been instrumental in developing and implementing plans to clean up many of these sites.

4. Source Controls and Remediation Efforts Planned

The Regional Boards have adopted a variety of different strategies to address water quality concerns, depending on the nature of the water quality problem. These include control of point source pollutants, control of non-point source pollutants, and remediation.

As stated in the LARWQCB's Basin Plan:

> "All discharges, whether to land or water, are subject to the California Water Code (§13263) and will be issued WDRs [Waste

Discharge Requirements] by the Regional Board." (LARWQCB 1994)

Control of Point Source Pollutants

Pollutants from point sources are transported to water bodies in controlled flows at well-defined locations. Examples of point sources include discharges from municipal and industrial wastewater treatment facilities. The primary mechanism for point source pollutant control is either through California's Waste Discharge Permit requirements or through the Federal National Pollutant Discharge Elimination System (NPDES) Permit requirements.

Control of Non-point Source Pollutants

Pollutants from non-point sources are diffuse, both in terms of their origin and mode of transport to surface and ground waters. Non-point sources of pollution originate from activities generating surface runoff that mobilizes and transports contaminants into surface and ground waters. Sources of concern include lawn and garden chemicals transported by storm water or by water from lawn sprinklers; household and automotive care products dumped on streets and into storm drains; fertilizers, pesticides, and manure washed from agricultural fields by rain or irrigation waters; sediment that erodes from construction sites; and various pollutants resulting from atmospheric deposition.

Emphasis is placed on pollution prevention through careful management of resources, as opposed to "cleaning up" the waterbody after the fact. Through public outreach—an example of a non-regulatory program—residents are informed of threats to the quality of the waters in their communities and are encouraged to voluntarily implement Best Management Practices (BMPs) that will eliminate or reduce non-point sources of pollution. Local governments, including the Counties and individual cities are encouraged to develop and implement ordinances and public outreach programs that supplement this effort. This flexible approach can be an effective means of controlling pollutants from many non-point sources.

In addition to the general approach to non-point source pollution control, the Los Angeles Regional Board has adopted a TMDL for trash for the East Fork of the San Gabriel River and has proposed a draft TMDL for trash in the Los Angeles River. The watersheds are also subject to a NPDES permit for stormwater runoff that is designed to protect the beneficial uses of water bodies in Los Angeles County by reducing pollutants in storm water. This permit was issued in 1990 by the Regional Water Quality Control Board and renewed in 1996. The permit covers 3,100 square miles in the Los Angeles basin and spans several watersheds, with the County of Los Angeles and 85 incorporated cities as the listed permittees. Orange County's Environmental Resources department also administers a county-wide stormwater program of water quality protection initiatives backed by a 1997 water quality ordinance.

Remediation

The Regional Board oversees remediation of both ground and surface waters through the investigation of polluted groundwater and enforcement of corrective actions needed to restore water quality. These activities are managed through a variety of cleanup and remediation programs. These programs are designed to return polluted sites to productive use by identifying and eliminating the sources of pollutants, preventing the spread of pollution, and deploying various treatment methods to restore water quality.

G. FLOOD PROTECTION

Flood management in the watersheds is the responsibility of the Los Angeles Flood Control District whose responsibilities are now performed by the Los Angeles County Department of Public Works, Orange County Flood Control District, and the U.S. Army Corps of Engineers. The Los Angeles Flood Control District was formed in 1915 in response to a devastating flood in 1914. In 1936, federal legislation gave flood protection duties to the U.S. Army Corps of Engineers (Corps), and the two agencies have worked jointly in Los Angeles County since then.

Flood protection is designed to contain and control runoff in order to prevent flooding. The size of a flood that would occur without any runoff management is often expressed in terms of its expected frequency. The larger the flood, the less likely it is to occur in any given year. For example, the size of the flood that is likely to occur each year is referred to as a one-year flood. It has a 100 percent probability of occurring in any particular year. Large events, such as the 20-year flood or the 100-year flood, have a 5 percent chance or 1 percent chance, respectively, of occurring each year. These calculations are estimates based on the historical record of rainfall and flood events in the County. Steep canyons in the mountains and foothills, combined with channel design and impermeable surfaces in the urban basin, promote rapid runoff during storms. Flood flows, which follow winter storms, are characterized by high peak flows and short durations.

1. Flood Management System

■ Historical Conditions

The San Gabriel and Los Angeles Rivers were prone to winter flooding in their natural state. This was due to a number of factors: the intensity of winter storms, the unstable nature of the riverbeds, and erodability of the stream banks. While large floods were infrequent, the magnitude of their destruction was sometimes devastating. In the early part of the twentieth century, damaging floods occurred in 1914, 1934, and 1938. The 1938 flood resulted in $78 million in damages ($889 million in current dollars) and the loss of 87 lives (Gumprecht 1999).

■ Existing Conditions

Flood management measures began in earnest in the 1920s. The present system, constructed by the Corps, was completed in 1970. The flood management system, the Los Angeles County Drainage Area (LACDA) system, consists of concrete river channels designed to expedite flow, dams and reservoirs to regulate flow, debris basins to capture sediment washed down from the mountains, and hundreds of miles of channels to direct flow into spreading basins and to the ocean. In excess of 100,000 acre-feet of local stormwater runoff is conserved in the spreading grounds annually. **Figure 2-13** illustrates the LA County flood management facilities in the watersheds, summarized in Table 7.

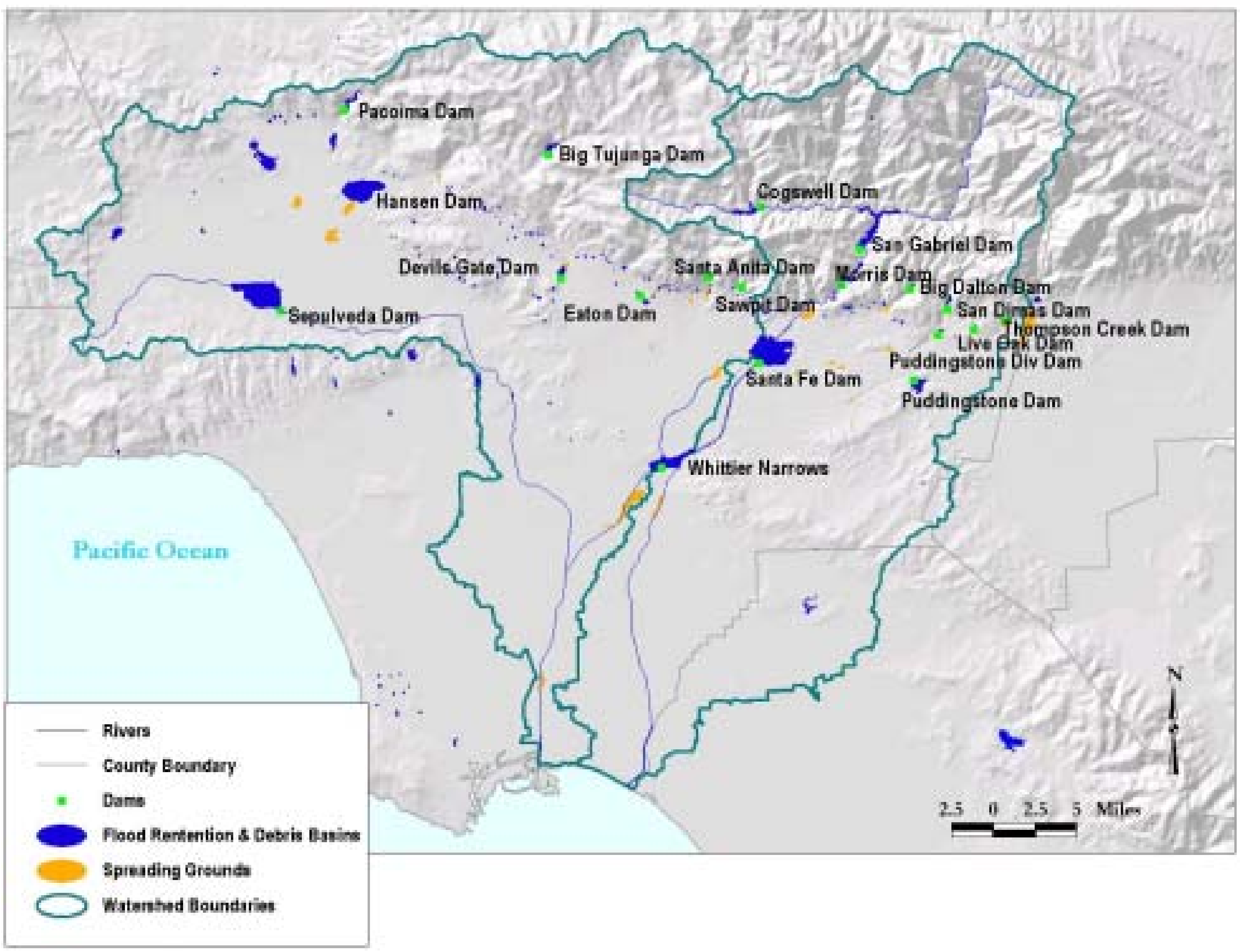

Figure 2-13. Los Angeles County Flood Management Facilities

Table 7. Los Angeles County Flood Management Facilities

Open channels	470 miles
Underground channels	2,400 miles
Flood management reservoirs	21
Rubber dams for diverting runoff	11
Groundwater recharge basins and soft-bottom channels	2,436 acres
Flood detention basins	5
Debris basins	116
Catch basins	75,000

The system developed by the U.S. Corps of Engineers was originally designed to provide flood protection for a 100-year flood. Flood events in the 1970s and 1980s indicated that perhaps the system did not have sufficient capacity. In 1991, a report prepared by the Army Corps indicated that the system was in fact not providing that level of protection, partially due to insufficient information available at the time of its design and partially due to the impacts of urbanization on runoff volumes. In some reaches along the lower mainstem of the rivers, LACDA only provided 25-year flood protection. Without further protection, damages from a 100-year flood were estimated to be as high as $2.3 billion and could affect a population of 500,000 in fourteen communities. In response, the Army Corps and the County initiated modifications to the LACDA system, known as the LACDA Project, to increase its flood capacity in the lower reaches. This project consisted primarily of increasing the height of the channel walls and reinforcing levees along the lower Los Angeles River in Long Beach, the Rio Hondo, and Compton Creek. Originally estimated to take ten years and $364 million to complete, the project is ahead of schedule due to increases in federal funding. It is expected to be completed by December 2001, at a cost of $200 million.

Steep slopes with high erosion rates and high intensity storms can result in high flows full of debris such as sediment, boulders, and vegetation. For example, San Gabriel Canyon, in the upper San Gabriel basin, generates an average of 1.3 million cubic yards of sediment annually. This situation is aggravated in areas that have burned and lost their vegetative cover. Debris basins in the foothills at the mouth of canyons are designed to trap sediment and other material carried by runoff, and help to retain channel capacity further downstream. These debris basins must be periodically cleaned out to retain their storage capacity. Excavated sediments are used as fill material, disposed in landfills, or delivered to approved sediment placement sites.

■ Role of Rivers in Flood Protection

The rivers are a major component of the flood protection systems. Flood flow is regulated with dams. The upstream tributaries of the San Gabriel River merge above the Santa Fe Dam (capacity of 32,109 acre-feet). The Whittier Narrows Dam (34,947 acre-feet) captures both the San Gabriel and Rio Hondo Rivers, but releases up to 36,500 cubic feet per second (cfs) of its flood flows into Rio Hondo diversion channel which connects to the Los Angeles River twelve miles above its outlet into the ocean. In large flood events some flow may be diverted into the San Gabriel River as well (up to 5000 cfs). The upper Los Angeles River flows into the Sepulveda Dam, a flood management facility operated by the Army Corps with a capacity of 22,493 acre-feet. Hansen Dam on the Tujunga Wash has a capacity of 25,441 acre-feet. Flood flows in the watersheds are also regulated by another 15 dams operated by the LACDPW.

2. Designated Flood Hazard Areas and "Unmet Drainage Needs"

The designated 100-year floodplain in the lower reaches of the Los Angeles River covers approximately 82 square miles, less than 6% of the two watersheds. Once the LACDA Project is completed, the extent of the hazard area will be reduced significantly and levels of protection increased to withstand a 133-year flood. There are still some small regions that are not provided with 100-year flood protection in the San Fernando Valley and below the confluence of the Arroyo Seco with the Los Angeles River.

The County tracks areas throughout the basin where flooding or drainage problems persist. Information is reported by the cities or through individual complaints, or directly to the County in unincorporated areas. Unmet drainage needs occur throughout the County but mostly in localized urban areas. If the situation requires a new drainage structure, the County will do a study to determine the best solution. The County is currently researching solutions for chronic flooding in the Sun Valley sub-watershed that will utilize alternative approaches to construction of a flood conveyance channel, such as detention basins and more permeable land cover. The goal is to retain runoff within the watersheds and provide multiple benefits beyond flood management.

H. REGIONAL DEMOGRAPHICS

1. Political Boundaries and Entities

■ Counties and Cities

While the majority of the watersheds lie within Los Angeles County, the area crosses into Ventura County to the west, San Bernardino County to the east and Orange County to the southeast. Within the boundary of the RMC, there are 66 cities in Los Angeles and Orange Counties. There are eight cities within the SMMC boundary.

2. Land Use

Within the watersheds, approximately 26 percent of the land area is urbanized and 25 percent is parks or open space, although most of that is the National Forest. Less than 30 percent of the land area is undeveloped, including vacant urban land and areas that are too steep to develop. Land use patterns in the watersheds are illustrated in **Figure 2-14**.

3. Population

The population of Los Angeles County is 9,519,338 (U.S. Census 2000). If the County were a state, it would rank ninth in the United States for population. While growth rates in the County have slowed, they are still significant: 7.4 percent over the past decade, or more than 656,000 people. By 2010, the County is expected to grow to 10,868,900, another 14 percent. **Figure 2-15** illustrates population growth in Los Angeles County. The eleven Orange county cities within the watershed contribute a total population of 770,500 people, an increase of over 100,000 since 1990. Between 1990 and 2000, Orange County's growth rate was twice that of Los Angeles County (US Census 2000).

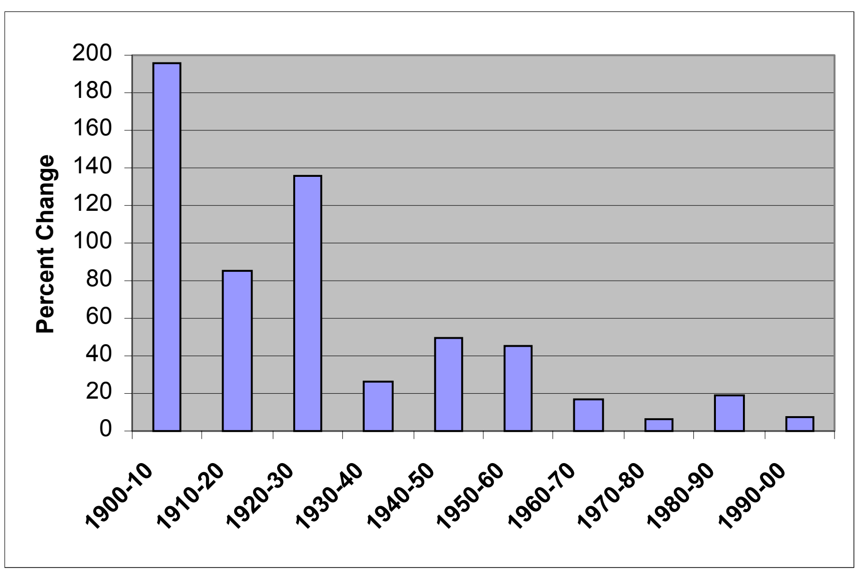

Figure 2-15. Los Angeles County Population Growth by Decade, 1900–2000
Source: Los Angeles Almanac

Population is concentrated in the valleys and coastal plain (**Figure 2-16**), with lower densities along the foothills, mountains, and outlying areas. The average density in Los Angeles County is 2,345 persons per square mile, compared with an estimated 42 persons per square mile in 1900.

4. Economic Conditions

■ Regional Economies and Industry

The Los Angeles basin has a large industrial base and a diversified, growing economy. Top industries include professional services, manufacturing, wholesale trade, tourism, and entertainment. Defense-related employment has been declining since the mid-1980s, while professional services, tourism, and manufacturing in sectors such as apparel and aircraft have increased both in numbers of jobs and in productivity.

The cities in the southern portion of the watersheds, the "Gateway Cities," call themselves the "industrial heartland" of Los Angeles County (SCAG 2001). With a population of approximately two million, they represent one in seven jobs in Southern California. Home to the Port of Long Beach, the area's economy is primarily based on manufacturing technology, trade, and tourism.

■ Median income

Median household income of residents within the area of the watersheds is $47,413 annually, ranging from $9,300 to well over $500,000 (1990 Census, 2000 projections). The lowest average income is found in the urban core, in the southern Gateway cities and South Los Angeles. The wealthiest households are along the coast and in the foothill communities (**Figure 2-17**).

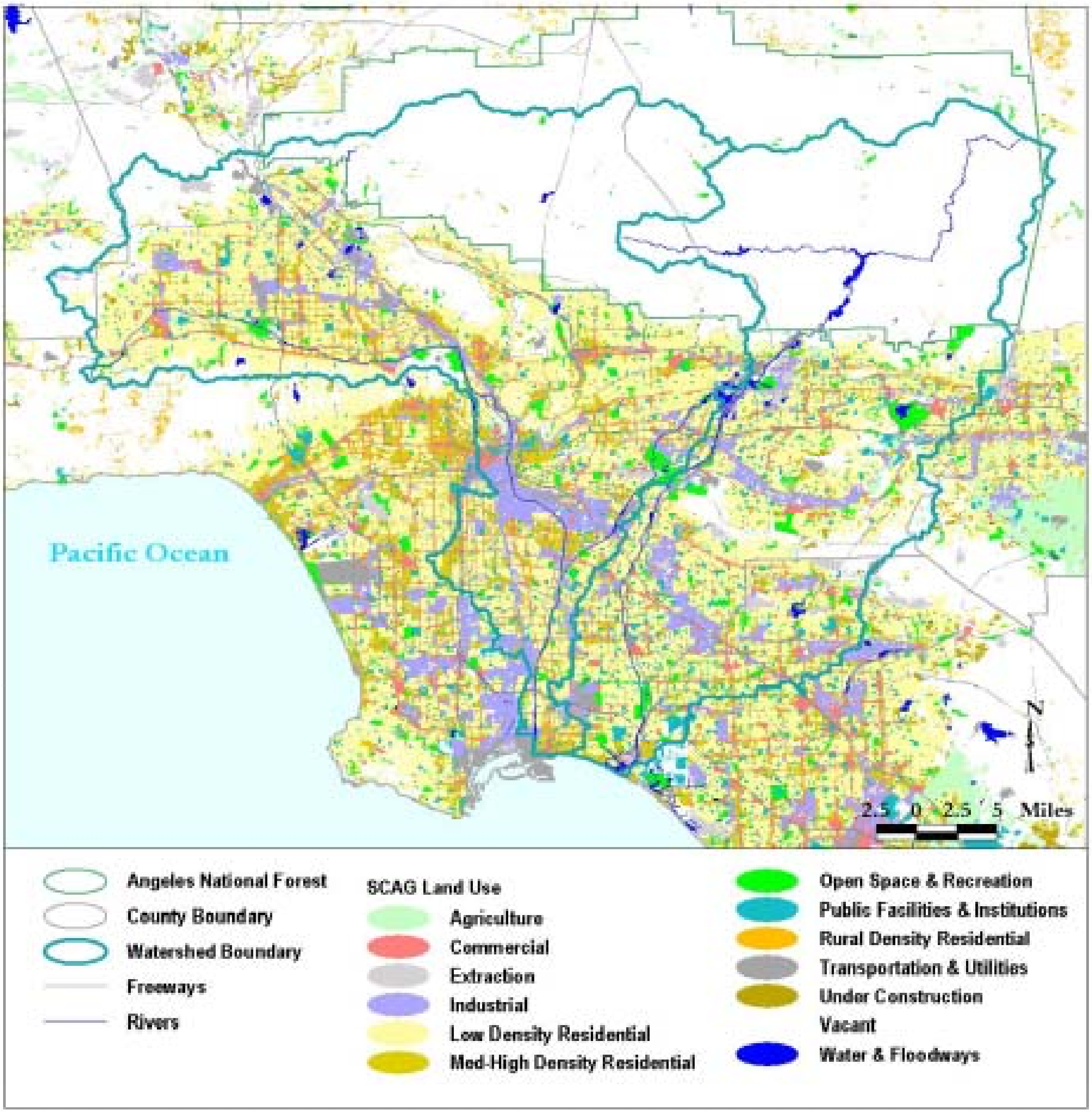

Figure 2-14. Land Use in the Watersheds
Source: Southern California Association of Governments 1993

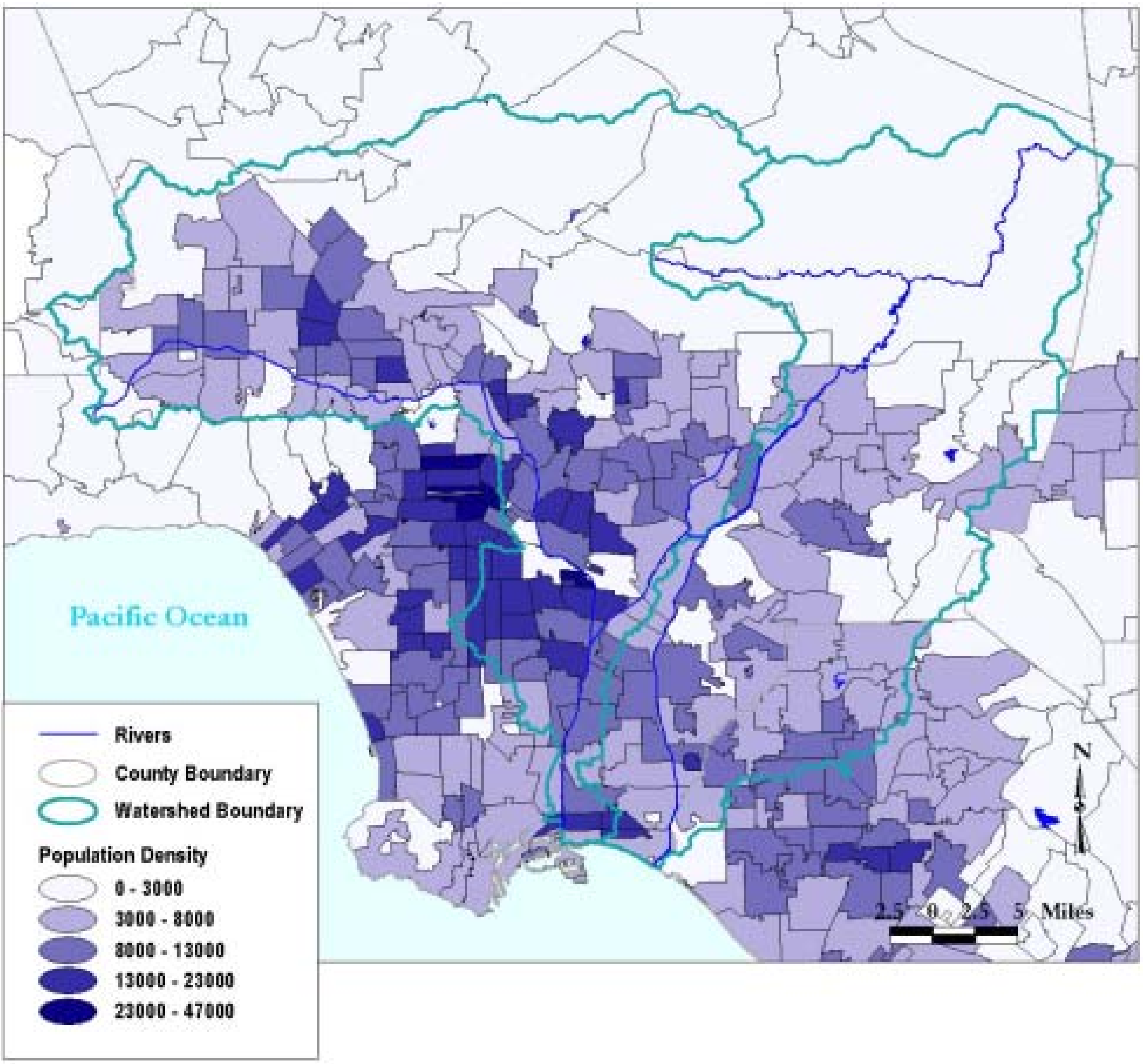

Figure 2-16. Population Density (Persons per Square Mile) by Zip Code
Source: US Census, 2000 Projected

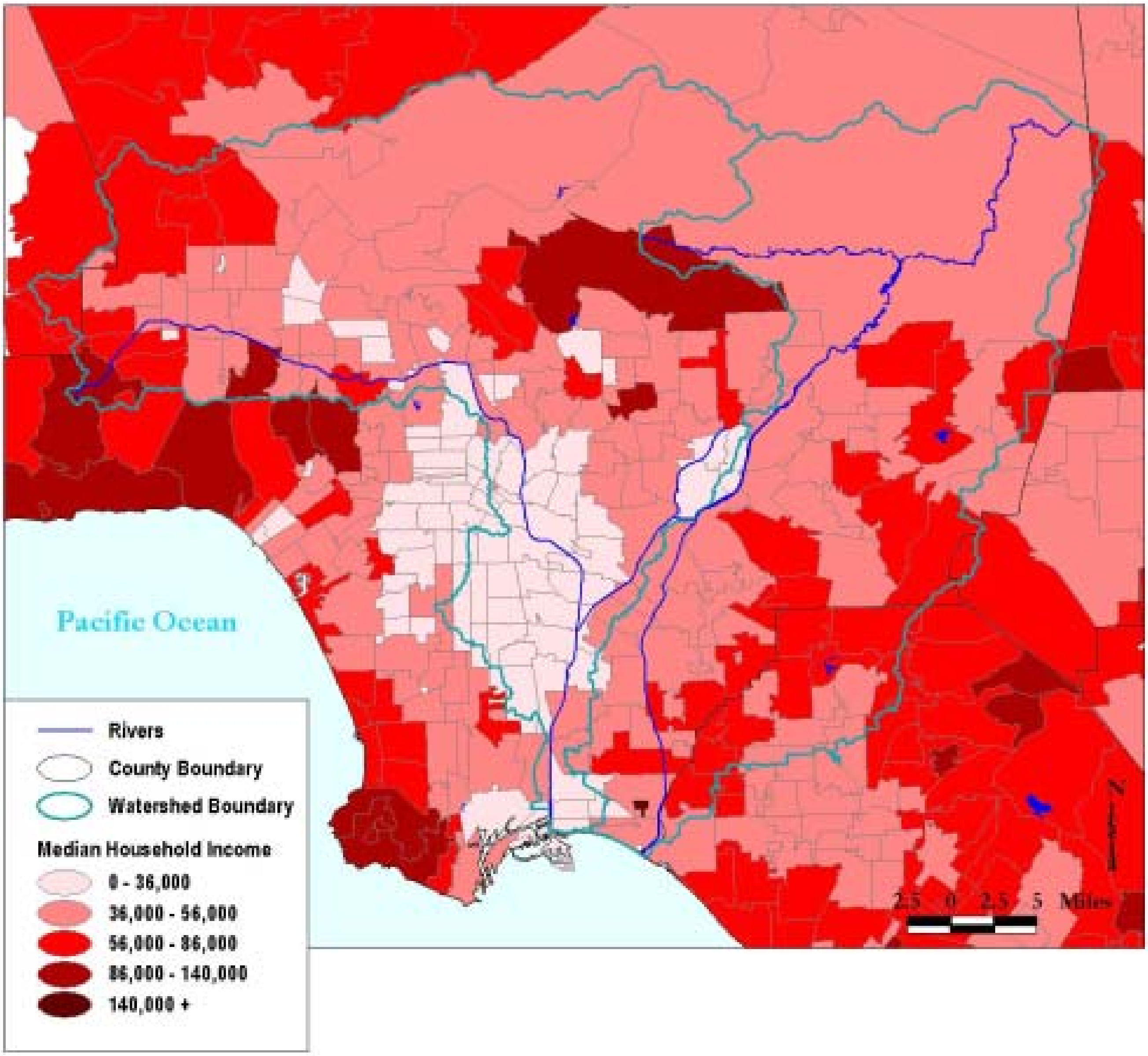

Figure 2-17. Median Household Income by Zip Code
Source: US Census, 2000 Projected